Final Report

Study on the renewable energy potential for electricity generation for national consumption in Tunisia and export to the EU

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

الشركة التونسية للكهرباء والغاز للطاقات المتجددة
STEG Energies Renouvelables

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Registered offices
Bonn and Eschborn, Germany
T +49 228 44 60-0 (Bonn)
T +49 61 96 79-0 (Eschborn)

Friedrich-Ebert-Allee 40
53113 Bonn, Germany
T +49 228 44 60-0
F +49 228 44 60-17 66

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de

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Acronyms

ADEME	Agency for Environment and Energy Conservation
AFI	Agriculture and Food Industry
ANME	National Agency for Energy Conservation
ANPE	National Agency of Environmental Protection
CESI	Italian Electrical and Technical Experimental Center
CHI	Chemical Industry
CIPIE	Inter-departmental Commission for Independent Power Production
CPC	Carthage Power Company
CPV	Concentrated Photovoltaic
CSP	Concentrated Solar Power
CSPIE	High Commission of Independent Power Production
Dii	Desertec industrial initiative
DNI	Direct Normal Irradiation
DGE	General Direction of Energy
DT	Tunisian Dinar
ETAP	Tunisian Enterprise of Petroleum Activities
FNME	National Fund for Energy Conservation
GHI	Global Horizontal Irradiation
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
GWh	Gigawatt hour
HV	High Voltage
HVDC	High Voltage Direct Current
IFI	International Financial Institutions
IMCCV	Industrial of Building Materials, Ceramics and Glass
IPP	Independent Power Producer
IRT	International Road Transport
ISCC	Integrated Solar Combined Cycle
kWh	kilowatt hour
MEI	Mechanical and Electrical Industry
MENA	Middle East North Africa
MV	Medium Voltage
MW	Megawatt
MWh	Megawatt hour
NMI	National Institute of Meteorology
NREL	National Renewable Energy Laboratory
LV	Low Voltage
PST	Tunisian Solar plan
PV	Photovoltaic
RE	Renewable Energy
RIP	Rate of internal profitability
TOE	Ton of Oil Equivalent
TTF	Title Transfer Facility
SONEDE	National Company of Water Exploitation and Distribution
STEG	Tunisian Company of Electricity and Gas
STIR	Tunisian Company of Refining Industries
VI	Various industries

INTRODUCTION

As part of its strategy to develop renewable energy projects, the European industrial initiative Dii (Desertec industrial initiative) plans to promote the implementation of several large-scale projects in the MENA region (Middle East North Africa). The realization of these projects requires the establishment of a set of technical and regulatory prerequisites. Dii intends to carry out a prefeasibility study for the implementation of a 1000MW Renewable Energy pilot project, in Tunisia. Tunisia's ambitions and Dii's objectives may converge to promote projects of mutual interest. In this context, this study is enrolled to investigate the potential of renewable energies for electricity production intended for national consumption, in Tunisia, as well as for export to the EU.

The objective of this study is to prepare the basis for a prefeasibility study for 1000 MW solar and wind power plants (400MW CSP, 300MW PV and 300MW Wind) that Dii will elaborate afterwards.

While performing this study, initially planned for a 500MW pilot project, it turned out that it was possible without major constraints to develop a production capacity of 1000 MW, according to a timetable to be agreed upon, but that could be spread over the period 2014-2020 (some projects may be included in the Tunisian solar plan, being reviewed). In fact, a study on the Tunisian electrical grid jointly conducted by CESI and Dii has shown that the network extensions and reinforcements scheduled by STEG by 2016, installing 1000 MW of ER, even if 80% of the electricity produced would be dedicated to export (the worst case for network management), would require only minimal network reinforcements. Moreover, such generation capacity may itself justify the installation of a trans-Mediterranean cable.

The main tasks to be developed in this study include collecting and evaluating information on:

- The regulatory framework in the field of electricity and renewable energies in Tunisia
- Analysis of the energy sector and particularly the electricity sector in Tunisia
- The quantification of the potential of renewable energies resources (particularly wind and solar) and their technical and economic exploitability
- The country's infrastructure and its convenience with large-scale renewable energy projects
- Environmental and Socio-economic effects

I. The regulatory framework for the electricity sector

Several institutions are involved in the policies and strategies for electricity generation and the development of renewable energies, mainly:

• Ministry of Industry and Trade (MIC): development and implementation of the governmental policy in areas related to energy. The MIC includes a General Direction of Energy in charge of the follow-up and analysis of the evolution of the country's energy production and consumption as well as the development of energy efficiency and renewables.

• STEG: Tunisian Company of Electricity and Gas, a national company which main mission is to satisfy the needs of the country in electricity and gas. The activities of STEG cover electricity production, transmission and distribution. Development of renewable energy projects is managed by the DEP (Department of Studies and Planning) and more specifically by the REEEP (Renewable Energy and Energy Efficiency Projects).

• ANME: National Agency for Energy Conservation. The mission of ANME is to implement the state's policy in the field of energy conservation and the rational use of energy, the promotion of renewable energies and energy substitution. The contribution of ANME includes all initiatives and actions to improve energy efficiency and diversify energy sources.

• High Commission of Independent Power Production (CSPIE): inter-ministerial committee, in charge, mainly of deciding on conditions of the concessionaire's selection, the choice of the independent producer and the benefits to be granted to the concessionaire (Decree No. 96-1125 of 20/06/96) for each independent power generation project. The CSPIE is composed of the Prime Minister (Chairman), Minister of International Cooperation, the Minister of Finance, the Minister of Trade, Minister of Industry, the Secretary General of the Government and the Governor of the Central Bank.

• Inter-departmental Commission for Independent Power Production (CIPIE): Committee within the Ministry of Industry in charge of independent power production projects: tender, negotiations with independent producers, proposal of grants for the concessionaire. The Commission shall submit, for approval, its findings and recommendations to the CSPIE. The CIPIE is chaired by the Minister of Industry and composed of one representative from each member of the CSPIE and STEG.

• IPP Group: charged to prepare specifications, strip offers, negotiate project agreements, related to concessions in the energy sector. It is composed of representatives from the Ministry of Industry and STEG.

1. Law on Production

The monopoly of power generation was raised by the law N°96-27 of April 1, 1996 that authorizes the state to grant to independent producers, IPP, concessions of power generation for the exclusive sale to STEG.

2. Law on Cogeneration

Since 2001, Tunisia has adopted regulatory provisions encouraging the development of cogeneration and authorizing the sale of electricity to STEG. The regulatory framework on cogeneration is governed by the following terms:

- Decree 2002-3232 of 3 December 2002, completed and modified by the decree N°2009-3377 of 2nd November 2009
- Bylaw of Ministry of Industry and Technology on 24th December 2007, approving the specifications on the technical terms for connection and discharge of electrical energy from cogeneration power plants on the national grid.
- Law N°2009-7 of 9th February 2009 modifying and completing the law N°2004-72 of 2nd August 2004 which introduced important elements for promoting the cogeneration, in particular for production, transmission and sale of electricity.
- Bylaw of 18th June 2009 fixing transmission and sale tariffs of electricity excess to STEG in accordance with technical conditions for connection to the national electricity grid and tariffs of sale of surplus production to STEG.
- Bylaw of 18 June 2009 fixing the rates of transport and sale of excess electricity to STEG and the technical conditions for connection to the national grid.

In this context, ANME has mobilized considerable efforts to develop this technology and has provided interested developers with a number of incentive measures, including:

- The granting of an investment premium amounting to 20% of the amount of the investment with a ceiling of 500 000 TND, served by the National Fund for Energy Conservation (FNME);
- The possibility of subscribing to bank loans with favourable terms on the credit line for energy management, managed by the ANME and financed by the French Development Agency (AFD);

- The possibility of subscription to bank loans on the credit line "Energy Efficiency in Industry & Cogeneration" of the World Bank, managed by ANME in complement to other financing tools (FODEC / FNME, guarantee fund in case of an ESCO).

However, cogeneration projects are subject to the following conditions, which might affect the speed of development of this branch in Tunisia:

- The need for any promoter to achieve an annual overall efficiency on the installation of cogeneration of at least 60%.
- The sale of electricity excess to STEG is done according to the following upper limits:
  - The 2/3 of the electrical energy produced, for projects with installed capacity less than 3 MW;
  - Half of the electrical energy produced, for projects with installed capacity equal to or greater than 3 MW.
- The promoter of the cogeneration system should bear the costs of strengthening the grid for the evacuation of the surplus of electricity on the grid, and the costs of connecting the installation to the national grid.
- The selling price of the excess of electrical energy produced is indexed to the purchase price of natural gas (price of the thermie of gas) applied to the company and set according to the four time shifts (day time, peak, evening and night).

3. Laws for the electricity production from renewable energies

The main regulations governing energy conservation are:

- Law N°2004-72 of 2nd August 2004 on energy conservation, allowing the publication of new laws and regulations to support energy conservation actions.
- Law N°2005-82 of 15th August 2005 which created the National Fund for Energy Conservation (FNME), a tool for funding sustainably the energy conservation field.
- Decree N°2005-2234 of 22nd August 2005 fixing the rates and amounts of premiums of actions regarding the FNME and modalities to grant them.
- Law N°2009-7 of 9th February 2009 modifying and completing law N°2004-72 of August 2nd, 2004 which introduced important elements for promoting renewable energies, in particular for the production, transmission and sale of electricity.
- The decree N°2009-362 of 9th February 2009 modifying and completing the decree N°2005-2234 of 22nd August 2005, introducing in particular investment aids for the realization of electricity production projects from renewable energy sources.
- The decree N°2009-2773 of 28th September 2009 fixing conditions of electricity transmission, sale of the surpluses to STEG and the upper limits of these surpluses. The prices are fixed by a decision of the Minister in charge of Energy.

Direct aids granted by the FNME are supplemented by specific tax benefits for energy conservation:

- Application of minimum customs' duties and suspension of VAT on equipments and products used for energy conservation which don't have a locally manufactured equivalent.
- Suspension of VAT on equipments and energy saving products purchased locally.

These benefits are to be added to the general regime governed by the investment code, which provides a number of advantages and investment incentives depending on sectors and investment zones.

4. Law on Self-production

The law N°2004-72 relative to the energy conservation modified and completed by the law N°2009-7 states:

- Article 7: establishments or group of establishments which are equipped with an energy efficient cogeneration installation for their own consumption, have the right to transport the electricity produced up to the point of consumption, and the right to sell excess of production to STEG, in a limit set by decree and in the context of a standard contract approved by the supervisory authority of the energy sector.
- Article 14 bis: establishments or group of establishments that produce electricity from renewable energies for their own consumption, have the right to transport electricity up to the point of consumption (if the generation and consumption points are distant), and the right to sell the excess of production to STEG in a limit set by decree and in the context of a standard contract approved by the supervisory authority of the energy sector. These projects are approved by decision of the minister in charge of energy taken on the advice of a technical advisory committee. This technical advisory committee was created by Decree No. 2005-2234 of 22 August 2005. It is chaired by the General Manger of the ANME and composed of representatives of the Minister of Industry, the Minister of Finance, the Minister of International Cooperation, the Minister of Environment and STEG.

Decree 2009-2773 fixes the conditions of the transmission of the produced electricity from renewable energies and the sale of the surplus to STEG. This decree states that:

- Article 1: The limit of energy that can be sold is 30% of the electricity annually produced. This limit may be exceeded by biomass installations with an installed capacity that doesn't exceed 15 MW.
  « Le transport de l'électricité et la vente des excédents s'effectuent dans le cadre d'un contrat-type approuvé par l'autorité de tutelle du secteur de l'énergie sur la base de tarifs de transport et de vente fixés par décision du ministre chargé de l'énergie ».

Translation : The electricity transport and the sale of excess are set in the context of a standard contract approved by the supervisory authority of the energy sector on the basis of transmission and sale tariffs set by a decision of the minister in charge of Energy.

- Article 3: The self-producer shall pay the costs of the connection to the grid and those of strengthening the grid if needed. Connection and energy discharge conditions are defined by specifications.
- Article 4: It is the technical advisory committee which advises on the implementation of self-production projects and it is the minister in charge of energy that approves the viewpoint of the Committee. The viewpoint of the committee is based on a technical file that includes:

  - An extract of the trade register of the company,
  - A technical and economical feasibility study,
  - The implantation site of the project and the electric power to be installed,
  - The consumption site of electricity,
  - The annual electric consumption of the establishment,
  - The expected annual production of electricity.

5. Law establishing the National Fund for Energy Conservation (FNME)

The law N°2005-106 of 19th December 2005, Finance Act for 2006, and in particular articles 12 and 13, established the national fund for energy conservation, (Official Gazette "JORT" N° 101 published on 20th December 2005).
This fund is intended to finance energy efficiency operations, promote renewable energy and energy substitution. This fund provides subsidies for the transactions targeted by Article I of Law No. 2005-82 of August 15, 2005 on the establishment of an energy management system.
The National Fund for Energy Management is financed by:

- Resources from the fund interventions
- The resources mentioned in Article 2 of Law No. 2005-82 of 15 August 2005 on the establishment of an energy management system
- Donations and grants from individuals and legal persons to the fund
- Any other resource that can be assigned to the fund under the legislation.

In 2010, the FNME financed up to 21 million dinars.

6. Independent production

Since its founding in 1962 by decree Law No. 62-08, STEG had the monopoly for electricity production, transmission and distribution throughout the Tunisian territory, besides, the decree allows some independent producers to generate electricity for their own consumption and sell the surplus to STEG (self-producers regime). This monopoly was partially lifted by Law N°96-27 of 1st April 1996 that authorizes the state to grant independent producers "IPP" concessions of power generation for exclusive sale to STEG

by a PPA. The terms and conditions of granting the license are set by Decree No. 96-1125 of 20th June 1996, specifying in particular the following:

- The selection of the concessionaire is done on a competitive basis through open tender or restricted tender preceded by a pre-qualification, an ad hoc group (group IPP) is charged by the ministry of industry to conduct the tender.
- The High Commission of the Independent Power Production (CSPIE) is an inter-ministerial commission, mainly in charge of the choice of the concessionaire for each independent power production project.
- The Interdepartmental Commission of the Independent Power Production (CIPIE) within the Ministry of Industry is mainly in charge of suggesting the benefits to be granted to the concessionaire, to review the offers and to submit for decision, its findings and recommendations to CSPIE.
- The CIPIE is also responsible for monitoring the negotiations with the selected independent producer until the agreement between him and the Ministry of Industry is signed. This agreement should specify the characteristics of the concession including its duration, benefits if any, granted to the concessionaire as well as the verifications and checks that can be achieved by the Ministry of Industry and the information to be provided by the concessionaire[1].
- The criteria, the scoring system and the conditions of the tender are set by the CIPIE in agreement with the opinion of the CSPIE.

It is in this scope that the first private power plant (Rades IPP) was implemented and started in 2002 by BOO mode (Build Own and Operate).

The hydrocarbons code promulgated by Law N°99-93 of August 17, 1999 completed and modified by Law N°202-23 of 14th February 2002, authorizes the holder of an operating oil concession to enhance the value of the gas of their plant by the production of electricity and its sale exclusively to STEG.

7. Approvals and permits

There is no specific text relating to authorizations and permits required for the realization of a Renewable Energy power plant.

The realization of a Renewable Energy Project must be approved by the Minister in charge of Energy, on the notice of the technical advisory committee (chaired by the Director General of ANME) which advises on the basis of a technical dossier consisting of:

- Extract from register of commerce of the company

[1] *One of the main remarks that can be made on the institutional framework is the lack of a single regulatory body. This role is currently implicitly undertaken by the Ministry of Industry.*

- Technical and economical feasibility study
- Project implementation site and installed capacity
- Energy consumption site
- Yearly energy consumption
- Yearly generation forecast

The deadline after which the Committee gives its opinion is not specified but can be estimated at about one month.

In addition, several other licenses or permits may be required:

- **Ministry of Agriculture**

Agricultural lands as defined by law are divided into three categories: closed areas, areas of backups and agricultural areas. The change in use of these areas is only possible by the publication of a decree proposed by the Minister of Agriculture, on the advice of the technical advisory committee of regional farmland.

A request including the following documents must be sent to the Ministry of Agriculture:

- Exact location of the land in the agricultural zone
- Project design features and its implications for water pollution, soil and air
- Agreement in principle on the project issued by the ministry concerned (Ministry of Industry and Technology)

After consideration, the dossier is forwarded to the concerned governor to submit the study to the opinion of the regional technical advisory committee.

The Governor shall, within a period not exceeding two weeks, display the request in the governorate headquarters, or the delegation of the municipality and the regional commissionership of agricultural development for a month and the publication of a notice in a newspaper to the certification of any applicant that may, during that time, submit observations on that point. These submissions may be presented directly to the Governor or by registered letter with acknowledgment of receipt. After expiration of one month, the Governor shall convene the Committee to consider any comments and issue its opinion on the request within 15 days after the posting period. He shall immediately refer the matter to the Minister of Agriculture. The change of agricultural land classified as conservation areas or other agricultural areas is done by decree at the proposal of the Minister of Agriculture.

In the event of non commencement of the project, subject of the change of the land's dedication, within a period of one year renewable once, the decree on the change of use of the land is repealed.

- **Ministry of Transport**

Authorization from the Ministry of Transport may eventually be necessary. In fact, any new objects or elevation of existing objects within the zones burdened by aeronautical clearing and marking of obstacles must be subject to prior approval from relevant departments of the Ministry of Transport based on digital data in accordance with procedures established by order of the Minister of Transport.
An application accompanied by a presentation of the project should be addressed to the Minister of Transport for its approval if the project's implementation is in these areas.

- **Ministry of National Defense**

Cases requiring the authorization of the Ministry of Defense are not well defined. It would be preferable to make a request, accompanied by a presentation of the project to the Minister of Defense.

- **Environmental Permits**

Decree No. 2005-1991 of 11/07/2005, which supplements and repeals Decree No. 91-362 of 13/03/1991, provides that Environmental impact studies are required for electricity generation facilities having a capacity of more than 300 MW.

The environmental impact studies are carried out by consultants or experts, and then approved by the National Agency of Environmental Protection (ANPE), which is based in the Ministry of Environment. The period within which the Agency has to give its opinion is three working months. If at the end of this period the ANPE has not given its opinion, the agreement for the project is considered tacit.

Power plants having a capacity of less than 300 MW do not require an environmental permit, it is however common practice that an impact study is accomplished.

- **Connection to the grid permit**

Decree No. 64-9 of 17/01/1964 approving the specifications for the supply of electricity, makes the responsibility of the subscriber connection fees to the national electricity grid.

Permission to connect to the grid is managed by STEG. A technical file must be submitted. When the connection is made in Low Voltage, STEG has a period of 25 days from the date of submission. If the connection is made in Medium or High Voltage, the deadline is 60 days. The cost of grid connection will be determined by STEG following a technical study.

- **Land Permits**

The project owner may set up on owned land or leased land to a private person or on land in the public domain (State Domain).

In the latter case, the producer is required to conclude a concession contract as an occupying of a public domain. The contract must specify the fate of the equipment installed after the expiry of the concession period and in accordance with Law No. 2008-23 of 01/04/2008 on the rules of concession.

- **Authorization for power lines**

To be able to cross national parks or natural reserves, power lines are subject to the approval of the Minister of Agriculture and this in case the operation raises public interest and the crossing of national parks or natural reserves is essential for the transport of the electrical energy produced.
An application accompanied by a study of the electricity transmission must be sent to the Central Registry of the Ministry of Agriculture - Directorate General of Forestry. An answer may be expected within 15 days from the date of filing the application.

8. Regional Renewable Energy Market

- **Moroccan RE Market**

Morocco has set up the Moroccan Solar Plan as a national strategy for development of Renewable Energies. This plan aims to install a power generation capacity using solar energy of 2 GW by 2020. The plan also includes the introduction of a new legislation for renewable energy and energy efficiency and the creation of a fund specially dedicated to this purpose.
The goal for 2020 is to reach 40% of renewable energy (about 6 GW) divided between, 2 GW solar, 2 GW wind and 2GW hydraulics.

Law 13-09 on Renewable Energy sets out requirements, including self-generation, grid connection and the ability to export electricity. It is possible to sell electricity to the national operator or directly to a consumer or consumer group. It is not intended to set a RE favouring pricing.

- **Algerian RE Market**

Algeria has implemented an ambitious program of development of renewable energies with the aim of installing a capacity of 22 GW by 2030, from which 10 GW are intended for export.

The Algeria wishes to become a major player in the field of RE and aims in particular the establishment of an important job creating local industry.
The incentives to be implemented are the reduction of duties and taxes (customs, VAT ...) on equipments, tax credits for companies that wish to become self-producers via RE and the facilitation of access to land for such projects.

- **Regulatory Framework EU**

The current European regulatory framework encourages the development of renewable energy. The European Union also supports the development of RE in the southern basin of the Mediterranean by the commitment of partnership within the Union for the Mediterranean and the Mediterranean Solar Plan.

Directive 2009/28/EC for the promotion of renewable energies can contribute to the development of RE projects outside the EU borders. Article 9 of this directive provides that the energy produced in a third country may be recognized on account of a member state in order to achieve its RE goals for 2020.

Member countries of the European Union, like Germany, Spain, France and Italy have established a Feed in Tariff system, specific to each country and each renewable energy technology (wind, PV, CSP ...) to subsidize and encourage the development of RE.

II. Organization of the electricity sector

The structure of the electricity sector in Tunisia is formed by:

- A national utility (STEG) having the largest share of production (85% power) and the monopoly for electricity and gas transmission and distribution throughout the country.
- A limited liability company (Carthage Power Company: CPC) belonging to two shareholders (Marubini and BTU Ventures, an equity group), CPC has only one combined cycle plant of 471 MW. It was commissioning in 2002 under the law N°96-27 of 1st April 1996 that authorizes the state to grant independent power producers IPP concessions for power generation and sale by an exclusive PPA to STEG.
- A limited liability company (Electricity company El Bibane BEEM), having two gas turbines totalizing a power of 27 MW, commissioned in 2003, in the framework of the law N°202-23 of 14th February 2002, which authorizes the holder of an oil operating concession to enhance the value of the gas from its oil fields for power generation and the exclusive sale to STEG.
- The industrial self-producers or co-generators that can produce electricity for their own consumption and that can sell part of their production to STEG.

In 2010, the part of STEG in the production was 73.8%, CPC and BEEM produced 20.6% and self-producers represented about 5.6% of the total production.

1. Electricity generation

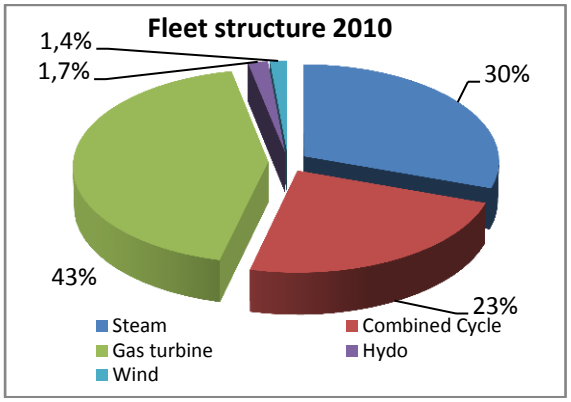
The Tunisian generation fleet, having a capacity of 3960 MW (2012), consists of:

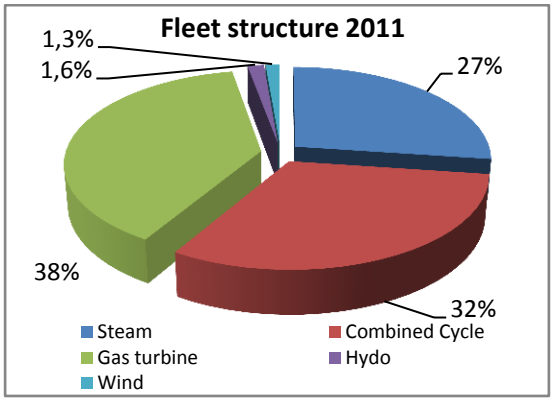
- Four main power plants that operate in base of a total capacity of 2 271 MW.
  Five plants equipped with gas turbines, unit power of 120 MW that operate mainly in peak and with a total capacity of 1080 MW.
- A set of small gas turbines, unit power of 22 or 34 MW with a total capacity of 440 MW spread over eight sites and running in peak time.
- A 54 MW wind farm in Sidi Daoud in the north-east of the country.
- Six hydraulic power plants with a total capacity of 66 MW.

- A 120 MW wind farm in the Bizerte region (50 MW already commissioned in 2012) and scheduled extension to reach 190 MW.

The Tunisian generation fleet is characterized by a significant number of gas turbines operating in open cycle, mainly to satisfy demand during peak time.

The following charts show the distribution of installed capacity by type of means of production for the years 2010 and 2011.





Source : STEG

Figure 1: Structure of the Park for 2010 and 2011. *Source : STEG*

The fleet's current production (gross installed capacity)

Power Plant	Name of the plant	Type	Installed capacity (MW)		Fuel	Number of units	Commissioning year	efficiency (%) 2010
Rades I	Rades A	steam	170		Gas/oil	2	1985	33
	Rades B		180			2	1998	35
Ghannouche	TV	steam	30			2	1972	28
Sousse	Sousse A	steam	160		Gas	2	1980	32.5
	Sousse B	combined cycle	364	120		1	1994	44
				120		1		
				124		1		
IPP Rades II	Rades II		471			1	2002	44
IPP El Biben	Biben		13,5			2	2003	22
Ghannouche			416			1	2011	52.5
Tyna	GT1/2/3	Gas turbines	120		Gas	3	2004/2010	29
Feriana	GT1/2		120			2	2005/2009	29
Goulette	GT1		120			1	2004	30
Bir Mcherga	GT1/2		120			2	1997	28
Bouchemma	GT1		120			1	1999	28
20 MW	GT		22		Gas	3+1+1+2	1975 - 1978	21
30 MW	GT		34			2+1+2	1977 - 1984	22
20-30	GT		22-34		Diesel	2+1+1	1978 - 1984	20
Hydro			66			6 plants		
Wind	Sidi Daoud		53,6			1	2001-2009	

Table 1: Current generation park. *Source : STEG*

National Production (GWh)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Thermal	5343,6	5688,4	4291,8	4659,9	4625,8	5343.9	5173,7	5926,2	6410.6	6017,3	5799
Hydraulic	64,4	54,4	64,2	166,0	153,5	145,2	91,7	48,6	38,0	78,9	50
Gas turbine	1 195,1	1 909,4	1678,3	1525,0	1244,2	1209,2	1505,3	1806,8	2120,8	2390,9	2786
Combined cycle	2595,7	2111,2	2206,1	1918,6	2597,0	2422,3	2823,2	2211,2	1641,6	2228,9	2795
Wind	23,1	23,6	30,1	33,4	43,7	42.4	37,6	42,9	39,4	97,5	139
Total STEG	**9221,9**	**9787,0**	**8270,5**	**8302,9**	**8664,2**	**9163,0**	**9631,5**	**10035,7**	**10250,4**	**10813,5**	**11569**
Self Producers	873,7	906,1	940,8	928,8	946,5	938,8	925,1	877,6	894,5	871,9	876
CPC	-----	160,8	2070,1	2459,7	2716,0	2765,2	2864,0	3054	3338,3	3154,6	3223,8
SEEB	___	___	___	139,2	127,6	139.7	0,0	0,0	101,7	114,3	2,3
Total Tunisia	**10096**	**10854**	**11281**	**11831**	**12454**	**13061**	**13420**	**13968**	**14585**	**14954**	**15671**

Table 2: National Generation. *Source: STEG*

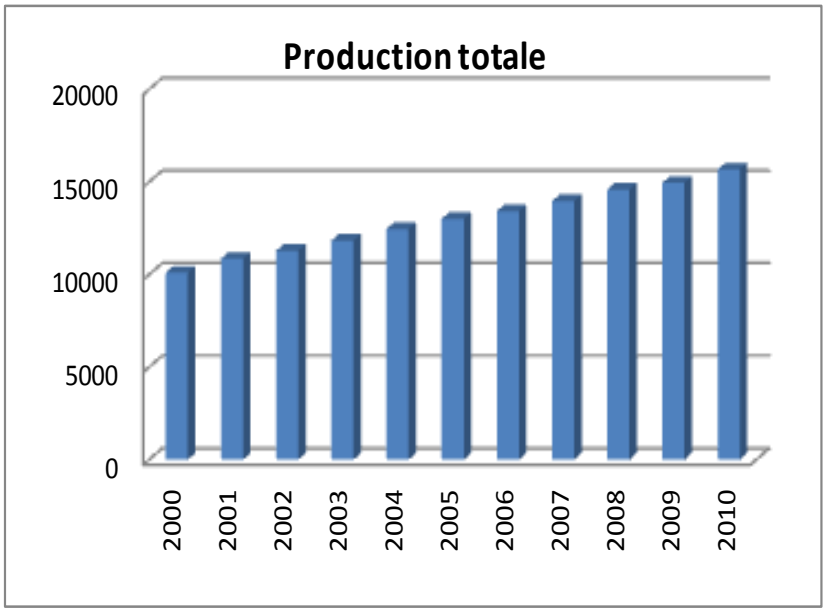


Figure 2: Total Generation. *Source : STEG*

Specific Consumption

The specific consumption of the national generation fleet has improved notably after the commissioning of the CCGT Rades II (CPC) in 2002 and a better management of the generating facilities (2006).

Moreover, the commissioning of the 416MW Ghannouche single shaft combined cycle in 2011 will also have a positive impact on improving the generation fleet's efficiency.

Specific Consumption (Tep/GWh)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
STEG	253,2	259,7	262,8	264,3	256,5	255,4	252,3	255,3	259,9	258,7	256,3
CPC		255	196,5	195,8	193,6	196	194	198,9	197,7	198,3	197,2
TOTAL	**253,2**	**259,6**	**249,4**	**248,4**	**241,2**	**241,3**	**238,8**	**241,9**	**244,5**	**244,8**	**243,3**
Variation	**-**	**+2,5%**	**-3,9%**	**-0,4%**	**-2,9%**	**-**	**-1%**	**+1,3%**	**+1,1%**	**+0,1%**	**+0,6%**

Table 3: Specific consumption of the park. *Source : STEG*

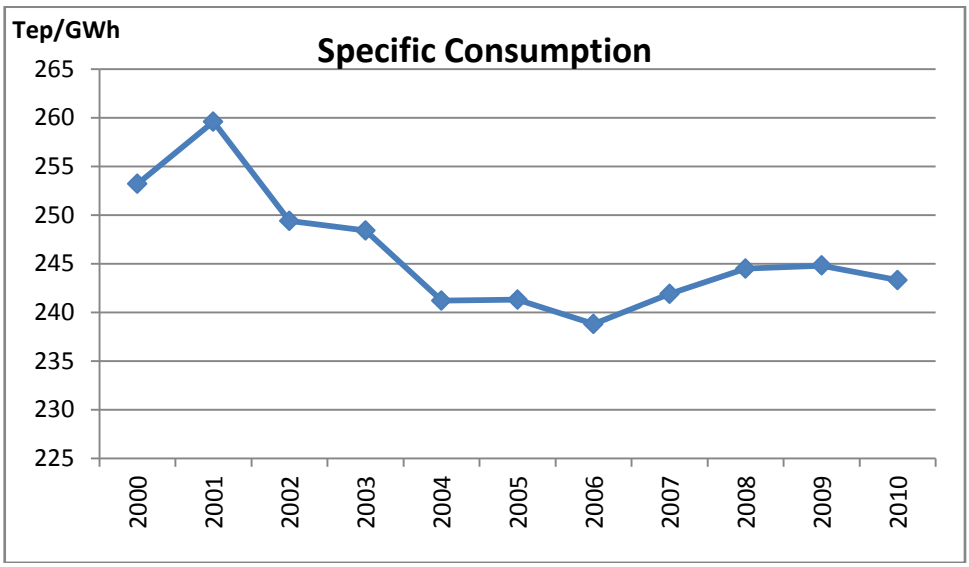


Figure 3: Specific consumption

The low specific consumption in 2006 was cyclical and coincided with the strengthening of the evacuation system of the platform to Rades, and a very good management and use of facilities.

2. Electricity production by type of fuel

Although the steam turbines of Sousse and Rades I are designed to operate with gas or heavy fuel, natural gas is mainly used for electricity production. The following table shows the structure of production by fuel for 2008, 2009 and 2010.

Fuel	2008	2009	2010
Natural Gas	9490.3	10135.5	11376.7
Heavy Fuel	682.1	501.1	1.98
Gas-Oil	0.6	0.5	1.33
Subtotal (GWh)	10173	10637	11380
Other Resources			
Hydraulic	37.9	78.9	50.1
Wind	39.4	97.5	138.6
Total (GWh)	**10250.3**	**10813.5**	**11568.7**

Table 4: Generation by fuel. *Source : Annual Report STEG 2010*

* On request of the Ministry of Energy, and when the gas prices in the international market is interesting, STEG operates some power plants (mainly Rades) on heavy fuel. The equivalent gas is sold on the international market.

3. Transmission and distribution

Voltage levels used for high-voltage grid are 400, 225, 150 and 90kV, the network consists essentially of overhead lines except in the capital, where, they are buried.
The high-voltage network is completed and connects all power plants to consumption centres.
The Tunisian network is interconnected with the Algerian network with two 90kV lines, a 150kV line, two 225 kV lines, a new 400 kV interconnection is under commissioning. Two 225kV interconnections with the Libyan network are built but not functional now.

The following table shows the lengths of the networks for different voltages:

Lines	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
225 kV	1 236	1 302	1742	2049	2 431	2 532	2 574	2 624	2 741	2 767	2 792
150 kV	1490	1516	1518	1529	1567	1728	1728	1728	1812	1812	1883
90 kV	968	962	965	1007	986	1071	1121	1141	1108	1188	1189
TOTAL	3694	3782	4225	4585	4984	5331	5423	5493	5661	5767	5 864
Variation	-	2.4%	11.7%	8.5%	8.7%	6.9%	1.7%	1.3%	3.1%	1.9%	1.7%

Table 5: Network by voltage *Source: STEG (Historical Statistics) / Annual Report STEG 2010*

STEG uses PLC (Power Line) for the purpose of remote operation of the electrical system, currently it generalizes the use of shield wires equipped with fibre optic transmission system for its data, especially after the commissioning of the new national control centre.

The distribution network is composed mainly of 30 kV overhead lines except in cities where there are underground 30kV, 15 kV and 10kV lines.

The following table shows the lengths of distribution networks and the number of clients:

DESIGNATION	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HV Lines (km)	40235	41760	43219	44823	46311	47020	47700	49309	50654	50634
LV Lines (km)	73951	76609	78745	81705	84003	85377	87000	89489	91859	92860
Clients (BT)	2 312 424	2 417 775	2 513 153	2 588 376	2 675 059	2 768 174	2 857 168	2 949 001	3 041 233	3 145 392
Variation	-	4.6%	3.9%	3%	3.3%	3.5%	3.2%	3.2%	3.1%	3.4%
Clients (MV-HV)	11927	12 379	12 860	13 352	13 906	14 400	14 946	15 106	15 124	15 671
Variation	-	3.8%	3.9%	3.8%	4.1%	3.6%	3.8%	1.1%	0.1%	3.6%

Table 6: Network Lengths and Number of Subscribers

STEG has undertaken since the 2000s an extensive program of rehabilitation of the distribution network for a double purpose: improving service quality and reducing technical losses.

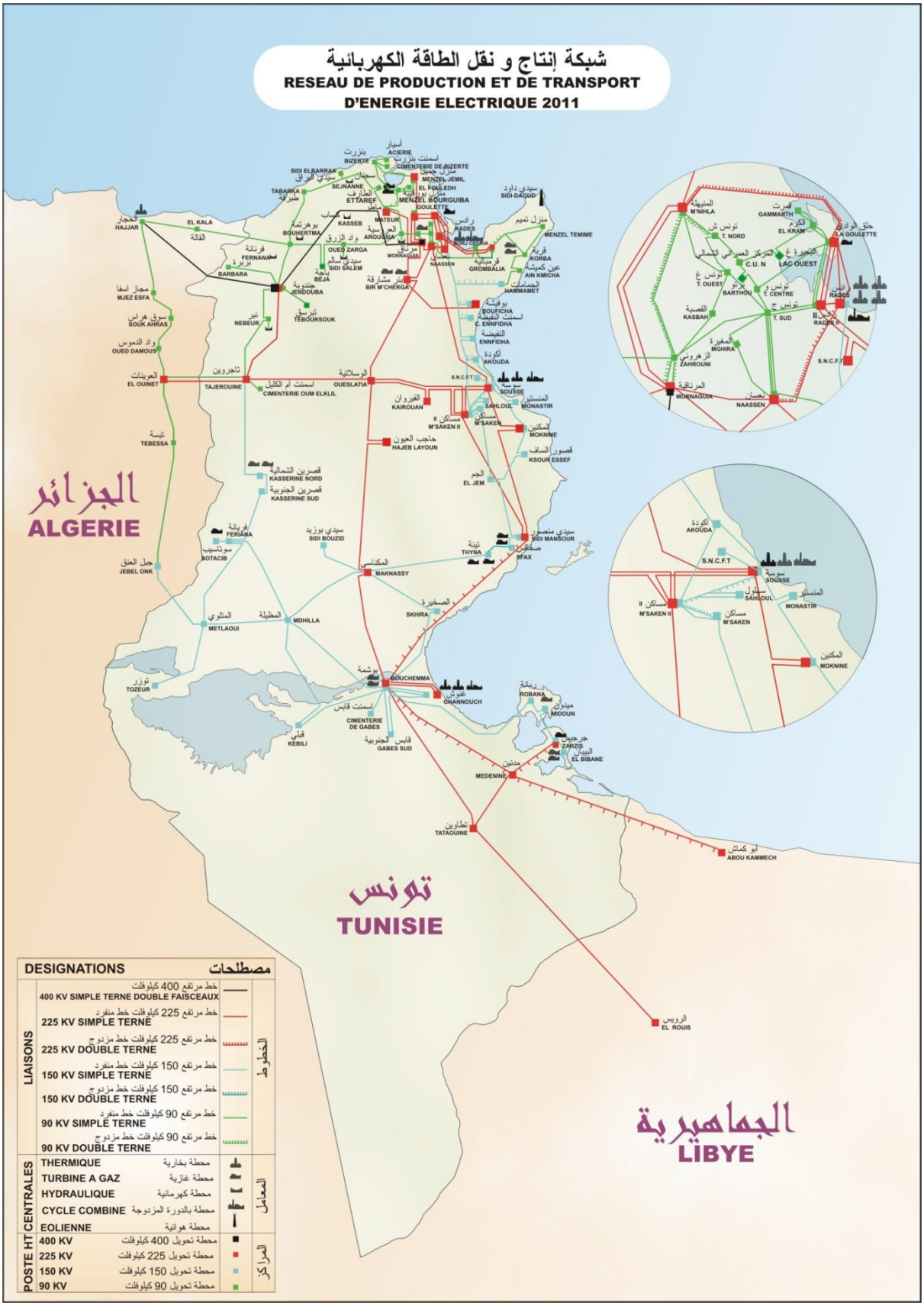


Figure 4: Generation and Transport Network STEG 2011. *Source : STEG*

4. Financial situation of the electricity sector

Even though the financial position of STEG is formally acceptable (in terms of ratios Debt / Equity or Debt / EBITDA), the company relies heavily on subsidies: tariffs do not cover costs, even in the Tunisian context where gas prices are lower than international prices.
Following the financial results of STEG for the years 2009 and 2010

Year	31/12/2010	31/12/2009
REVENUES	2 308 918 452	2 064 710 795
Operating subsidy	1 108 291 536	560 300 119
Cost of sales (Cost Price)	-3 267 066 657	-2 517 167 205
Gross margin	150 143 331	107 843 709
Other operating income	52 195 334	56 399 674
Administrative costs	-36 243 605	-37 478 223
Other operating expenses	-22 781 114	-19 685 319
OPERATING PROFIT	143 313 946	107 079 841
Net financial expenses	-136 374 613	-87 087 473
Investment income	1 787 580	187 179
Other ordinary gains	7 731 555	4 011 998
Other ordinary losses	-14 140 920	-6 271 163
Results from ordinary activities before tax	2 317 548	17 920 382
Income tax	-11 465 103	-9 010 607
NET INCOME FOR THE YEAR	-9 147 555	8 909
Effects of accounting changes	-28 309 256	
RESULT AFTER ACCOUNTING CHANGES	-37 456 811	8 909

Table 7: Financial ResultsSTEG 2009 et 2010 . *Source: Annual Report STEG 2010*

5. Electricity market in Tunisia

Currently the electricity market is characterized by:

- The national utility (STEG), having the monopoly for transmission and distribution of electricity and gas, nearly 80% of the electricity generation capacity, it is the sole purchaser of electricity generated by both IPPs and excess electricity produced by self-producers and co-generators.

- The law 2004-72 supplemented and amended by Law N° 2009-7 of February 9, 2009 applicable to the sector of self-production from renewable energies and cogeneration.

- The Ministry of Industry is the regulator of the sector.

Although the electricity market is currently relatively closed, the regional context suggests an evolution towards a market opening. In fact, Tunisia, Algeria, Morocco and the European Commission (as a promoter, not involved) signed in Rome in December 2003 a memorandum of understanding for the gradual integration of electricity markets of these three countries in the internal European electricity market.

Electrical and gas interconnection projects, between Tunisia and Italy on the one hand and Algeria and Spain on the other hand, are likely to accelerate the integration of the Euro-Maghreb energy markets.

Electricity demand

Net electricity consumption in Tunisia amounted to around 13.67 TWh in 2010, incorporating both electricity supplied by STEG and that produced and self-consumed by industrial companies mainly.
In the year 2010, electricity sales, by STEG, increased by 6.2% from 12254 GWh in 2009 to 13015 GWh in 2010.
The structure of electricity demand, by voltage, progressed as follows:

- Demand on High Voltage (HV : 90/150/225/400kV), increasing by 3.5% per year on average, lost weight during the past 10 years and represents 10% of electricity demand in 2010 against 12% in 2000.

- Demand on Medium Voltage (MV: 10/15/30kV), increasing by 5% per year on average, stagnating at around 47% of the demand in 2010.

- Demand on Low Voltage (BT: 400/230V), which has evolved faster, with an increase of 5.1% per year, represents 43% of the demand in 2010, versus 40% in 2000.

Total Demand (Sales and Self-producers) GWh

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
High Voltage	908.6	946.0	926.2	915.8	963.9	1030.0	1106.7	1141.3	1192.1	1201.8	1292.9
Medium Voltage	3904.6	4248.4	4367.8	4525.0	4801.0	4934.6	5039.8	5341.0	5556.6	5620.4	6042.4
Low Voltage	3340.3	3544.3	3792.1	4107.1	4227.2	4390.3	4673.1	4815.1	5085.6	5392.3	5532
Sales STEG	8153.5	8738.7	9086.1	9547.9	9992.1	10354.9	10819.6	11297.4	11834.3	12214.5	12867.3
Self-producers	826.1	858,2	876.8	873.0	891.7	879.5	874.0	822.0	827.0	805.0	805.3
Total Tunisia	**8979.6**	**9596.9**	**9962.9**	**10420.9**	**10883.8**	**11234.4**	**11693.6**	**12119.4**	**12661.3**	**13019.5**	**13672.6**
Variation (%)	-	6.9%	3.8%	4.5%	4.6%	3.2%	4.1%	3.6%	4.5%	2.8%	5%

Table 8: Total Demand 2000-2010. *Source STEG*

Sales by economic sector in GWh

ECONOMIC SECTOR	2008	2009	2010
Mining	366	330	355
Food & Tobacco Industries	530	551	583
Textile & clothing	537	503	543
Paper Industry & publishing	132	132	141
Chemical & Petroleum	289	307	333
Building materials industry	1292	1386	1443
Basic metal industries	219	241	288
Various industries	764	781	889
SUBTOTAL (1)	4129	4231	4576
Agricultural pumping	452	432	496
Pumping (water & sanitation)	515	488	536
Transport & communications	268	280	306
Tourism	641	634	632
Services	709	757	790
SUBTOTAL (2)	**2585**	**2591**	**2760**
Energy, prorates and others	33	17	9
TOTAL	**6747**	**6839**	**7345**

Table 9: Sales by Economic Sector. *Source : STEG Annual Report 2010*

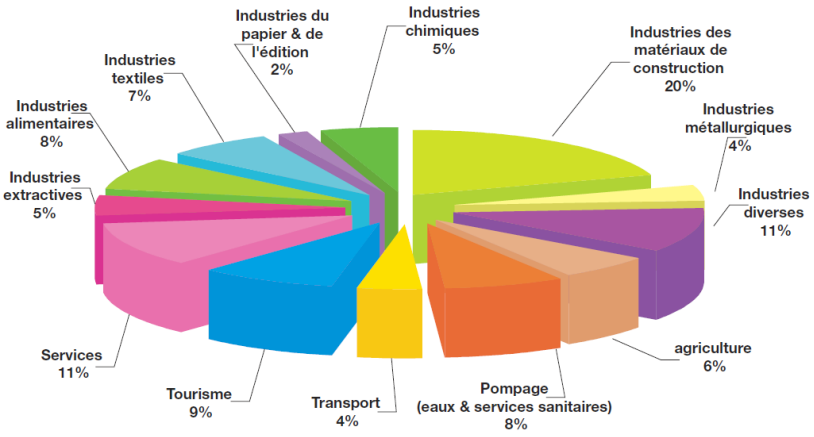


Figure 5: Sales by economic sector *Source : STEG*

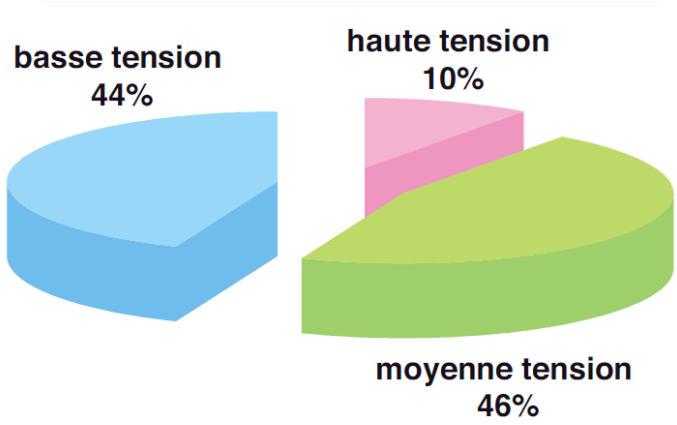


Figure 6: Sales by Voltage level *Source : STEG*

Voltage	2008	2009	2010
High voltage (HV)	17	18	18
Medium Voltage (MV)	14848	15106	15653
Low Voltage (LV)	2 949 001	3 041 233	3 145 392

Table 10: Number of client's progress *Source: STEG*

Load curve

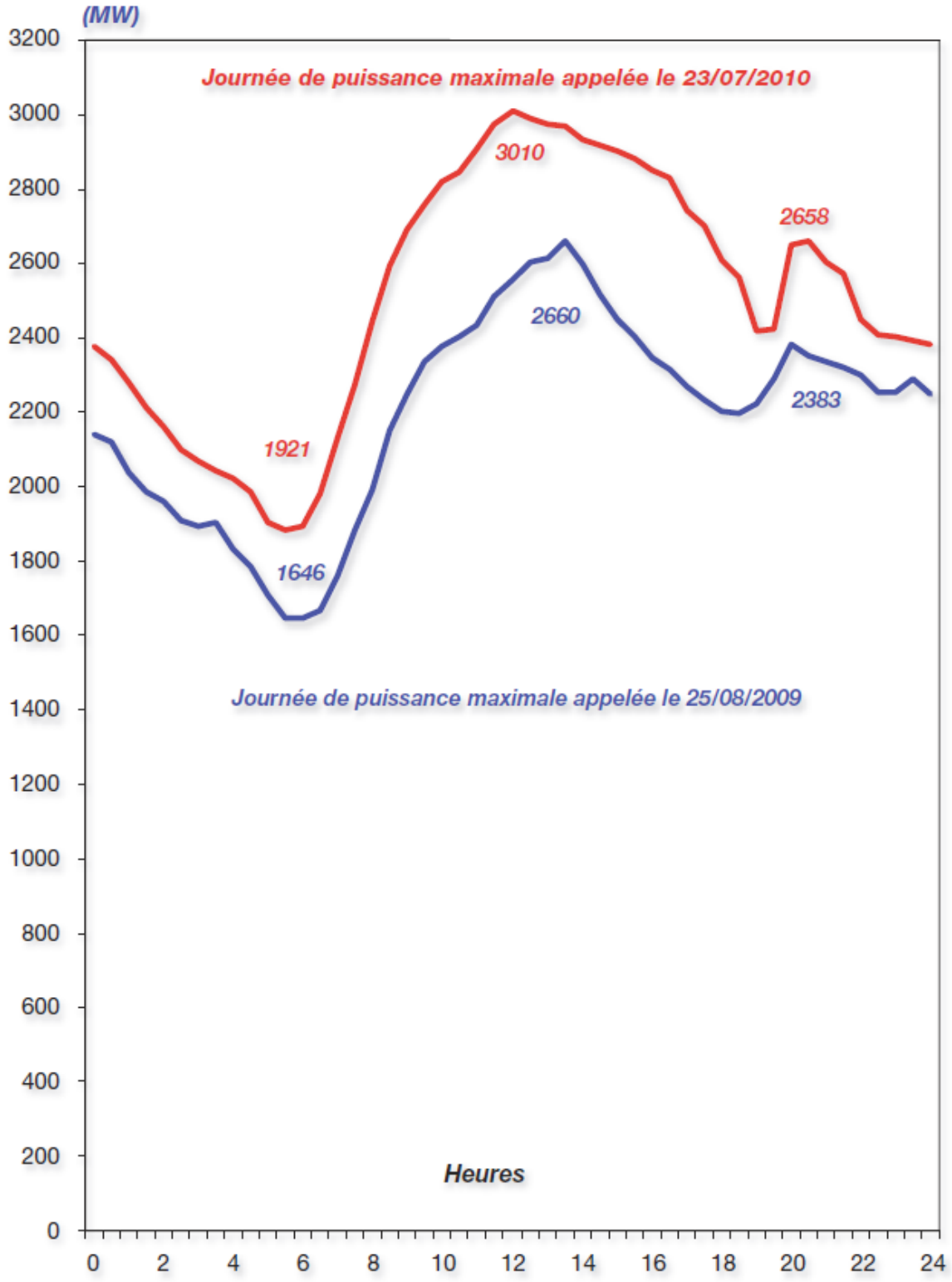


Figure 7: Load curve. *Source : STEG*

6. Prices and tariffs

In collaboration with relevant government agencies (DGE- General Direction for Energy, ETAP-Tunisian Enterprise of Petroleum Activities, STIR- Tunisian Company of Refining Industries, Ministry of Commerce, and Ministry of Finance), the Government sets the energy prices at all levels by decision of the Minister in charge of Energy[2] (MIC). Rates are set at the end of each fiscal year or if required and reflect the international price of crude oil and gas, the financial balance of businesses (STEG, ETAP, STIR) and the subsidy that the government is able to support.

The government sets the consumer price of electricity and gas, on STEG's proposal and after approval of the ministry. Electricity prices currently applied are summarized in the Table below.

Until 2004, STEG's prices reflected approximately production costs, and the grants (e.g. rural electrification, or tariffs for certain categories of rural consumers) were fed mainly by cross-subsidies between tariffs.

Since 2004, there was a threefold increase in international prices of petroleum products, and for STEG, a doubling of the purchase price of natural gas, which represents more than 90% of the fuel for electricity generation.

These increases were not echoed on STEG's tariffs, which no longer reflect the production costs, despite the still advantageous gas price awarded to STEG by the Tunisian state. The state compensates STEG annually to keep prices at this level.

The electricity tariffs are arranged by time slots for HV and MV and pumping water for agricultural irrigation. There are 4 time shifts "postes horaires": Day, Peak, Evening and Night. MV clients can, however, have a flat tariff, and 50% of consumption in MV is done according to the uniform tariff.

Similarly, the LV tariff is subdivided into three sub-tariffs: base tariff applied up to 300kWh per month, a normal tariff, applied to all kWh consumed above 300 kWh per month and a social tariff for customers subscribing less than 2kVA and consuming less than 50 kWh per month.

Electricity prices have increased many times in the last years. The average growth rate of these prices during the period 2000 - 2010 is about:

- 10 % per year for high and medium voltage
- 8 % per year for low voltage.

[2] *The Tunisian government decided the principle of price adjustment in 2004. The publication of energy prices, subject to decided adjustments, is made by decision of the Minister of Energy on a proposal from the DGE.*

Tariffs		Price of Electricity (mill/kWh) HV			
		Day	Peak	Evening	Night
Low Voltage LV					
Economic bracket (1 à 2 kVA et <= 50 kWh/year		75			
Economic bracket (1 à 2 kVA et > 50 kWh/year	1 à 50 kWh/month	92			
	>=51 kWh	133			
Ordinary bracket (>2kVA)	1 à 300 kwh/month	133			
	>=301 kWh/month	186			
Medium Voltage MV					
Normal		125			
Time shifts « Postes horaires »		110	168	133	85
Water Pumping		126	156	Load shedding	85
Secours (Tarif for self-producers that consume only in case of necessity)		128	180	150	90
High Voltage HV					
4 postes horaires		106	164	129	81
3 postes horaires		122	150	-	81
Secours		124	176	146	86

Figure 8: Electricity tariffs in millimes (2011)

Hourly positions are defined as follows, for every day of the week, except Sunday which consumption is uniformly charged and costs "Night":

- Tarifs à quatre postes horaires

MOIS	JOUR	POINTE	SOIR	NUIT
1er Septembre au 31 Mai	de 7h à 18h	de 18h à 21h	-	de 21h à 7h
1er Juin au 31 Août	de 6h 30 à 8h 30 et de 13h 30 à 19h	De 8h 30 à 13h 30	de 19h à 22h	de 22h à 6h 30

- Tarifs à trois postes horaires

MOIS	JOUR	POINTE	NUIT
1er Octobre au 31 Mars	de 6h30 à 17h30	de 17h30 à 21h30	de 21h30 à 6h30
1er Avril au 30 septembre	de 8h à 19h	de 19h à 23h	de 23h à 8h

Figure 9: Hourly positions *Source : STEG*

The following table gives the average selling price (including of all taxes) by voltage level for the period 2000 to 2010

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
HV	53.2	55.3	55.6	62.3	64.9	70.7	78.1	82.2	106.0	117.8	123.1
MV	71.4	73.7	74.6	78.3	82.2	89.1	96.4	101.2	120.6	130.5	138.7
LV	90.1	94.6	96.6	98.0	104.3	112.7	126.7	131.7	149.3	155.6	158.4
Average Price	77.0	80.2	81.8	85.2	90.1	97.4	107.6	112.3	131.5	140.3	146.9
Variation	-	4.2%	2.0%	4.2%	5.8%	8.1%	10.5%	4.4%	17.1%	6.7%	4.7%

Table 11: Average Sales Price by voltage level. *Source : STEG*

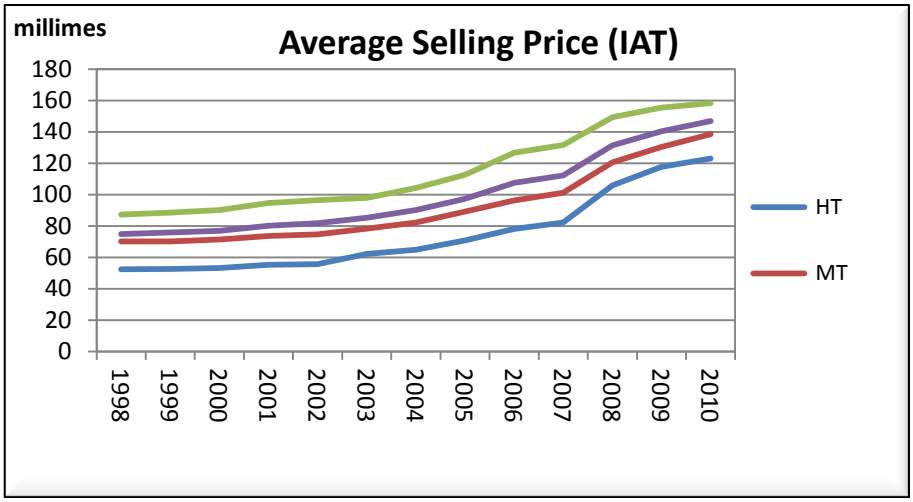


Figure 10: Evolution of the Average Sale Price

Taxation

The taxes on the sale price per kWh are:

VAT is to be applied to rates:

- 18% of all royalties and price of energy (excluding taxes) for uses other than domestic and irrigation.
- 12 % on energy prices (excluding taxes) for domestic purposes and irrigation.

An increase (municipal surcharge) of 0.003 DT is applied to the price of each kWh for all uses.

Subsidies

The sale prices of electricity and natural gas are administered and decided by the Ministry of Industry and Trade, the last tariff review was conducted in June 2010. Sale prices of electricity and natural gas do not cover production and distribution costs, the state grants a direct subsidy to STEG, and passes gas royalties from the Trans-Tunisian Pipeline to 90.8 DT / Tep. This price is lower than its current value and this to keep electricity and gas prices at a "socially acceptable price".

Grant Structure (2010)
For a gas price estimated at its international level, electricity subsidy would be:
Direct: 468,4 Millions DT
Gas royalty: 236,8 Millions DT

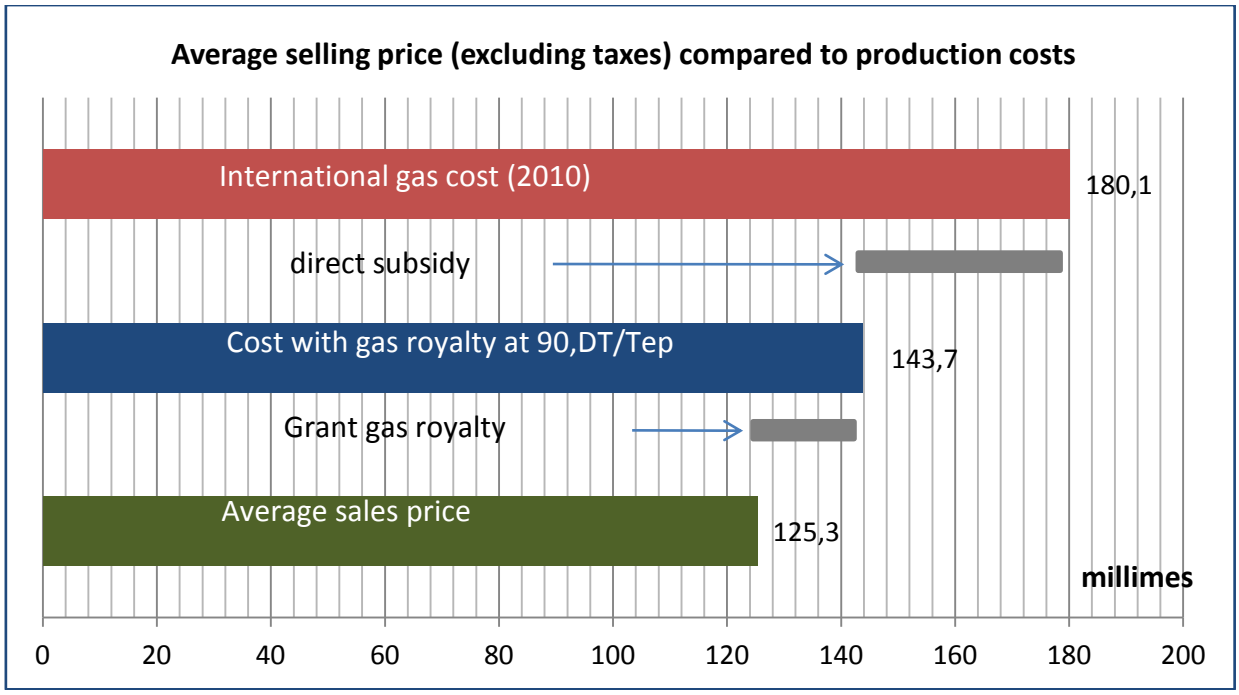


Figure 11: Average Sale Price per kWh *Source: Ministry of Industry*

7. Construction of new plants

STEG Production Program (2012-2016)

- To meet the increasing demand estimated at 5% per year without megaprojects (Sama Dubai, Tunis Financial Harbour etc. ..) and 7% per year if megaprojects are maintained, STEG has scheduled:
- A 450 MW Combined Cycle Power Plant in Sousse that will be commissioned in 2013;
- Another 450 MW Combined Cycle Power Plant in Sousse that will be commissioned in 2014;
- A 450 MW IPP plant in Kaalet Landlous

It should be noted that the first plant in Sousse is under construction, the second plant of Sousse tender is being analyzed and the Kaalet Landlous IPP plant the tender is not prepared yet.[3]

ELMED Project

The project has two separate components (possibly with separate fundings)

- Submarine interconnection of 1000 MW between Tunisia and Sicily (400 kV, HVDC, approximately 200 km);
- Production in Tunisia : 400 MW for the local market (contract with STEG), 800 MW for export to Italy (with a 200 MW capacity on the interconnection reserved for renewables).

The selection process was launched by the ELMED company, 16 bidders were shortlisted (including Mubadala, MacquarieCapital, Siemens, SNC Lavalin, Edison, Enel, Marubeni, Sumitomo, IP, BG, etc..). The formal tender must be published shortly (June 2012 according to the project's responsible).

Tunisian Solar Plan (TSP)

The TSP covers all the sectors of energy efficiency (transport, buildings and industry) and renewable energy sectors (solar, wind and biomass). Its implementation will involve the mobilization of public and private sectors, and will be supported by the use of institutional, regulatory and financial arrangements.

In the renewable energy field, the objective is to install a capacity of 1000 MW in 2016 and 4.7 GW in 2030 for the production of electricity from renewable energies. The TSP is also continuing the energy efficiency program in many fields, the aim is to reduce overall primary energy demand by 24% in 2016 and 40% in 2030.

Among the TSP projects, those relating to solar water heating, individual buildings roofs insulation and replacement of old refrigerators are generating substantial savings and reductions on greenhouse gas emissions.

For 2010-2016, 40 projects were selected for an estimated investment of about 4.1 billion Tunisian Dinars.

The Tunisian Solar Plan is currently being reviewed. ANME commissioned a consultancy study to adapt it to bring out the objectives for 2020 and identify more specific projects.

8. Evaluation of used technology

Production facilities meet the Tunisian standards in efficiency and environmental friendliness, for recent plants (Ghannouche and Sousse), STEG has opted for single shaft combined cycle which have an efficiency of 52%.

STEG plants are subject to periodic performance inspections, as well as water and atmospheric discharges control.

[3] ***Comments****: given the current situation (post-revolutionary) and possible delays in completion of the second plant of Sousse and the one of Kaalet Landlous, STEG might choose to purchase 120 MW or 250 MW gas turbines.*

9. History of the investments in the electricity sector

The following table shows the investments of STEG for the period 2005-2010 (Thousands TND):

	2005	2006	2007	2008	2009	2010
Production	56 000	61 000	85 600	76 800	662 000	484
Transmission	133 000	179 000	113100	93 600	63 000	69
Distribution	73 000	74 000	81 300	105 900	96 000	106
Gas	33 000	63 000	53 500	62 500	95 000	130
Diverse	5 000	5 000	8 500	8 400	10 000	13
TOTAL	300 000	382 000	342 000	347 000	926 000	802 000

Table 12: STEG Investissements for 2005-2010. *Source STEG*

10. Financial viability of the EE/RE projects

A study for a wind energy project in THALA for self-production, conducted by ANME and funded by GIZ, showed the following results:

Scenario	**Base Scenario**	**120MW Scenario**	**Optimistic Scenario**	**Pessimistic Scenario**
Variables:	60 MW	120 MW	60 MW	60 MW
Investments Costs [EUR]	65 316 464	122 203 896	65 316 464	71 848 110
Interest rate A	5,5%	5,5%	4,8%	6,5%
Interest rate B	6,0%	6,0%	5,5%	7,0%
Energy Production (kWh/y)	206 999 400	399 393 600	206 999 400	188 444 400
Increase in the weighted value of wind energy	1,2%	1,2%	5,0%	0,0%
CDM Certificate prices	5,0 EUR	5,0 EUR	12,0 EUR	0,0 EUR
Results				
(CMPL)	6,8%	6,8%	6,4%	7,6%
IRR	8,2%	9,2%	12,0%	2,6%
Production cost of wind farm (EUR/kWh)	0,0452	0,0444	0,0450	0,0545
Production cost of wind farm (TND/kWh)	0,085	0,083	0,084	0,102

Table 13: Feasibility Study "Wind farm self-producer" in Tunisia. *Source : (ANME)*

In this study, the investment for the evacuation of energy has been calculated on the basis of 150kV lines, 40km in length, about 7800 000TND.

11. Needs of the improvement of the electrical system

The analysis of the load curve shows an evolution in the peak power greater than that of the demand, as a result, a deterioration of the power utilization rate, an effort must be made by STEG to smooth the load curve and reduce the peak demand.

This can be achieved by introducing special tariffs such as erasure during the peak and a smart management of the load (Smart Grid).

In order to improve the power produced by gas turbines, in summer, it is possible to introduce the cooling technique of the intake air (Chiller).

Large scale use of photovoltaic on roofs can reduce demand during summer peak and improve the electrical system efficiency.

According to studies made by ANME, the technical and economical potential of cogeneration in Tunisia is estimated at about 600 MW of which about 430 MW in the industrial sector (which is equivalent of a 450MW combined cycle plant). However this potential has so far been under-exploited; in 2010 eight cogeneration units have been implemented or were under construction, a total power of about 37 MW with the objective to reach 70 MW by 2012.

12. Needs in investment for the electricity sector

To finance its production, transmission and distribution programs, STEG has always opted for IFIs funding (International Financial Institutions).

Investments for the period 2012-2016 are estimated:

450 MW Combined Cycle in Sousse	800 Millions DT
450 MW Combined Cycle in Kalaat Landlous	800 Millions DT
Elmed (400MW for tunisian market)	1000 Millions DT
HV Lines 400 kV (output of power plants, Interconnection 250 km)	250 Millions DT
TSP Projects	4100 Millions DT

* Investment at the expense of STEG

13. Evaluation of barriers for renewable energies' development and needs of assistance

- Lack of the regulatory framework for independent power production from large scale RE power plants (IPP), excluding self-producers.

- Lack of visibility on the investment costs borne by the proponent for the discharge of the produced electricity.

- Data available for the potentials of wind and solar energy do not provide sufficient precision to reduce investment risks; each developer must make an additional measurement campaign at his expenses.

- Lack of a clear procedure for priority of dispatching for the RE production.

- Need to complete the wind atlas developed by ANME by measurements at high altitude (installation of measurement masts and data processing).

- Capacity building of ANME for the evaluation of RE projects (training, courses, methods of investigation ...)..

- Improving procedures and deadlines for obtaining permits for projects of electricity production from renewable energies.

- Establishment of transparent procedures for managing production centres (network code).

14. Renewable energies and energy efficiency projects

A 50 MW (4 hours storage) CSP plant to be realized by STEG, the feasibility study underway by the german engineering office Lahmayer, estimated cost : 300 million €.

ISCC (Integrated Solar Combined Cycle) power plant of 20 to 40MW with 5MW CSP to be constructed at the El Borma oil platform, feasibility study in progress.

10 MW photovoltaic power plant by STEG, the feasibility study underway by the german engineering office Lahmayer, estimated cost : 20 million €.

Wind Farms as part of the big consuming facilities program (ANME: programme EGCE), estimated power 120 MW, feasibility study undertaken by ANME.

Cogeneration Projects: in the scope of the national program for energy efficiency, conducted by ANME, a list of cogeneration projects has been selected for the period 2010-2014. Some of them are realized or under construction others are in the feasibility study phase, as shown in the following table.

N°	Institutions	Field of Activity	Potential (MW)	Planned Economy (toe/year)	Planned investment (MDT)	Progress
1	RANDA + SMT	AFI	4,5	3600	8,1	Under negotiation of contracts with manufacturers
2	Tunisie Lait	AFI	2	1600	4	First phase of the detailed study completed
3	CLC DELICE	AFI	2	1600	3,6	First phase of the detailed study completed
4	Al KIMIA	chemistry	5	4000	9	study completed
5	SITEX KASRA HELAL with transmission of electricity to SITEX Sousse	TI	4,5	3600	8,1	Detailed study updated taking into account the transmission-project
6	Couscousserie Du Sud	FI	3,5	2800	6,3	Detailed study completed-Investment decision dependent on funding
7	BRIQ. MAZDOUR	IBMCG	2	1600	3,6	Detailed study completed-Investment decision dependent on funding
8	TUNISIE OUATE	Paper	3,5	2800	6,3	Detailed study completed-Investment decision dependent on funding
9	SOMOCER	IBMCG	4,5	3600	8,1	Detailed study completed
10	STIAL - DELICE DANONE	AFI	3	2400	5,4	Detailed prefeasibility study completed
11	LA ROSE BLANCHE (WARDA PASTA)	AFI	4,4	3520	7,92	Detailed feasibility study in progress
12	UNPA	AFI	4,5	3600	8,1	Detailed feasibility study in progress
13	BCM - BRICKYARD OF the CENTER MENZEL HAYET	IBMCG	7,6	6080	13,68	Detailed feasibility study in progress
14	BRICKYARD KALAA SGHIRA – BKS	IBMCG	5	4000	9	Detailed feasibility study in progress
15	BRICKYARD BENI KHIAR - BMB	IBMCG	3,5	2800	6,3	Detailed feasibility study in progress
16	SNCPA	Paper	11	8800	19,8	Detailed feasibility study in progress

17	BBM Brick Complex (GP): Grouping with transmission of electricity	IBMCG	5	4000	9	Detailed feasibility study in progress
18	Crystal Pet	CHI	5	4000	7	Feasibility study in progress
19	SARTEX	TI	1	800	1,8	Prefeasibility study completed
20	Carthage Grains	Oil refining	7	5600	7	Prefeasibility study completed
21	TUNFIB	Plastic	5	4000	7,5	Summary study in progress,
22	Société maghrébine des produits céramiques – SMPC	IBMCG	2	1600	4	Detailed feasibility study in progress
23	SLD	Milk	1	800	2	Detailed feasibility study in progress
24	SIAM	Pasta	1,5	1200	3	Detailed feasibility study in progress
25	IAT (Industrie alimentaire de Tunis)	cheeses	1	800	2	Detailed feasibility study in progress
26	GCCB	ceramic tiles	1	800	2	Detailed feasibility study in progress
27	MPC ESSID	ceramic tiles	1,5	1200	3	Detailed feasibility study in progress
28	KHARRAZ GRES CERAME	ceramic tiles	1,5	1200	3	Detailed feasibility study in progress
29	CICERAM	ceramic tiles	1,5	1200	3	Detailed feasibility study in progress
30	TUNISIE PORCELAINE	ceramic tiles	1,5	1200	3	Detailed feasibility study in progress
31	SANIMED	sanitary	1,5	1200	3	Detailed feasibility study in progress
32	Brickyard Jemmel	brickyard	1	800	2	Detailed feasibility study in progress
33	Brickyard Lahmar & compagnie BLC	brickyard	10	8000	20	Detailed feasibility study in progress
34	Brickyard El Faouz	brickyard	1	800	2	Detailed feasibility study in progress
35	Brickyard SMPC	brickyard	2,5	2000	5	Detailed feasibility study in progress

36	ICF	Chemistry	1,5	1200	3	Detailed feasibility study in progress
37	SFBT	AFI	0,4	320	1	Detailed study completed - Project being installed
38	GIPA COMPLEX-AL MAZRAA (GP)	AFI	5	4000	9	Turbine commissioned
39	Vitalait	AFI	2	1600	4	Feasibility study completed- tender launched
40	AZUR-Groupe LILAS	Paper	3,5	2800	6	order in progress
41	MAKLADA COMPANY MPS	MEI	4	3200	6	order in progress
42	MAKLADA	MEI	2	1600	4	Feasibility study completed- tender launched
43	Cartonnerie tunisienne	Paper	2	1600	3	Feasibility study completed- tender launched
44	GBNA	VI	1,1	880	2	Being installed
45	SLAMA FRERES	AFI	1,13	1250	2,3	Project completed commissioning in 2011
46	Aeroport Enfidha- TAV	Tertiary	4	1700	9,1	Project completed commissioning in 2011
47	Brickyard BBM (GP)	IBMCG	5	3900	3,5	Project completed commissioning in 2011
48	CARTHAGO CERAMIC	IBMCG	5	3800	6	Project completed
49	SOTIPAPIER	paper mill	10	6200	5,878	Project completed
50	SNA	VI	1,5	1100	1,25	Project completed
51	TEC TPAP	paper mill	5	4000	3,35	Project completed
52	CARTHAGO GRES	IBMCG	5	3500	3,714	Project completed
TOTAL			180,13	140 250,0	289,7	

Table 14: Cogeneration Projects *Source ANME*

III. Renewable energies potential in Tunisia

1. Technologies' Overview

This study will mainly focus on three technologies offering the greatest potential: CSP, PV and Wind. Other technologies, such as biomass and geothermal will not be approached.

CSP (Concentrated Solar Power)

The basic principle of a CSP plant is to convert solar energy into heat, which will be used to drive turbines. Solar radiation is focused to achieve the necessary operating temperatures.

There are many technologies for solar concentrators. There are those with line-focusing systems (parabolic trough, Fresnel mirrors) and those with point focusing concentrators (power tower or Dish Stirling). The following figure shows the main concentration systems.

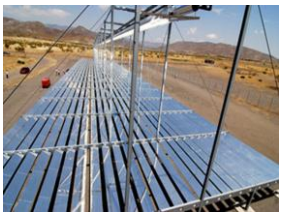
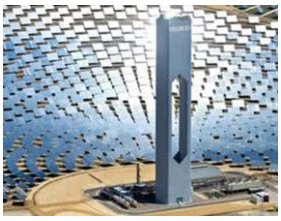
Parabolic Trough	Fresnel Mirrors	Tower	Dish Stirling
			

Figure 12: Main CSP technologies

Among CSP technologies, parabolic trough is the most common and proven technology by today. The solar rays are reflected by the cylindrical mirror to converge towards a collector tube, located along the focal line of the reflector, and in which a heat transfer fluid (oil, molten salt, water ...) circulates. This heat is used to produce steam that will be injected into a turbine to generate electricity.

Fresnel mirrors linear focusing is quite similar to parabolic trough mirrors. The idea is to approximate the parabolic shape of the collector using a series of flat mirrors. One of the advantages of this technique is its low complexity.

In Power Tower plants, we use several mirrors (heliostats) that concentrate sunlight onto a receiver located at the top of the solar tower. Each heliostat tracks the sun and reflects the rays towards the receiver in which circulates a heat transfer fluid (oil, molten salt, water, air ...). Concentration factor ranges from 600 to several thousand, which allows to reach high temperatures (800 °C to 1000 °C).

The parabolic mirror (Dish Stirling) reflects the sunlight towards a focal point; solar radiation is concentrated on the receiver that heats up. The receiver is a Stirling engine which operates through the rise in temperature and pressure of a gas contained in a closed chamber. This engine converts solar thermal energy into mechanical energy and then electricity. The performance of the whole system is closely related to the optical quality of the dish and to the Stirling engine performance.

The figure below shows the countries with high potential for CSP energy production as well as completed or in progress projects.

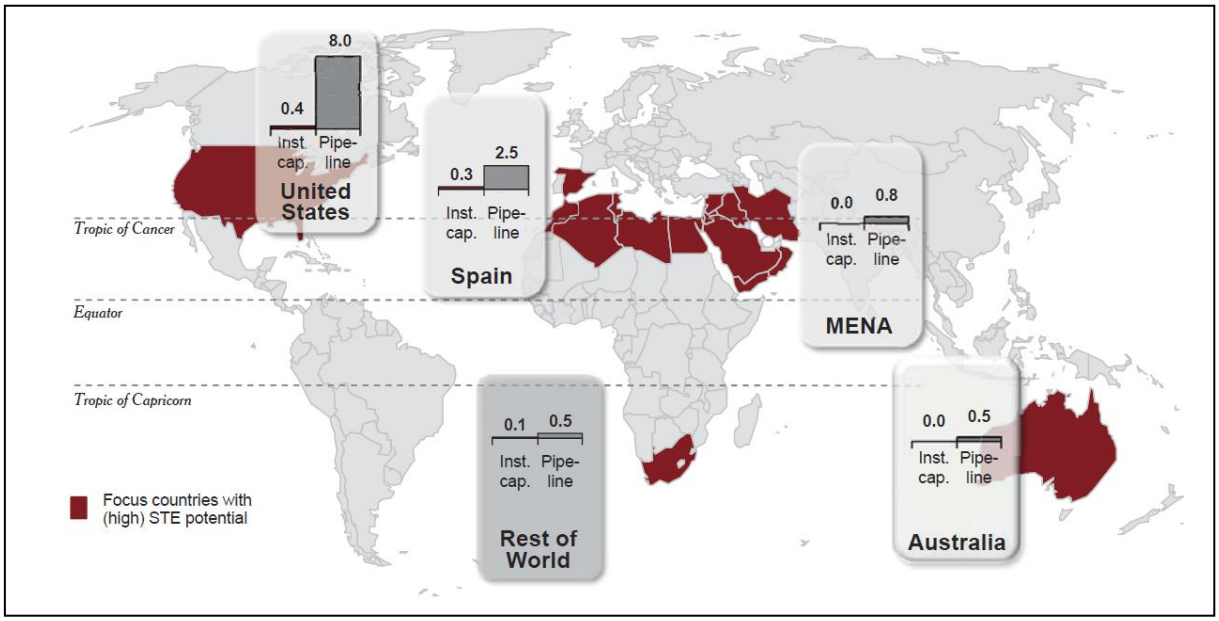


Figure 13: CSP Projects by 2015

Source: A.T. Kearney SOLAR THERMAL ELECTRICITY 2025

Photovoltaic (PV)

PV modules convert sunlight directly into electricity (DC). An inverter converts Direct Current produced by modules into an Alternative current with the same characteristics as the grid. There are various technologies of photovoltaic modules; the most used is crystalline technology with 90% of PV installed capacity. Commercial modules have efficiency around 14-15%, while some prototypes have achieved efficiencies of around 20%.

The second most common technology is thin films. This type is less expensive but efficiencies are also lower (11-13%).

There are other technologies such as CPV (Concentrated Photovoltaics) or organic cells. The cells (CPV) are placed in a focus that concentrates the sunlight. Their performance exceeds 30-35%, but they must have a tracking system to follow the path of the sun.

Organic cells are composed of organic semiconductors, disposed on a substrate of plastic or glass. This technology is still experimental, has a moderate efficiency (10%) but presents interesting opportunities of cost reduction.

Wind energy

A wind turbine is a machine that converts wind's kinetic energy into mechanical energy.

The operating principle of a wind turbine is relatively simple: wind turns the blades (usually three) who are themselves running the generator located in the nacelle. The generator

converts the mechanical energy of wind into electrical energy. The advantage of this technology is that it is already competitive compared to conventional technologies. Its drawbacks are its intermittency and it does not offer storage options at an attractive price.

2. Wind potential

The following figure shows, for the MENA region, sites with the most interesting wind potential.

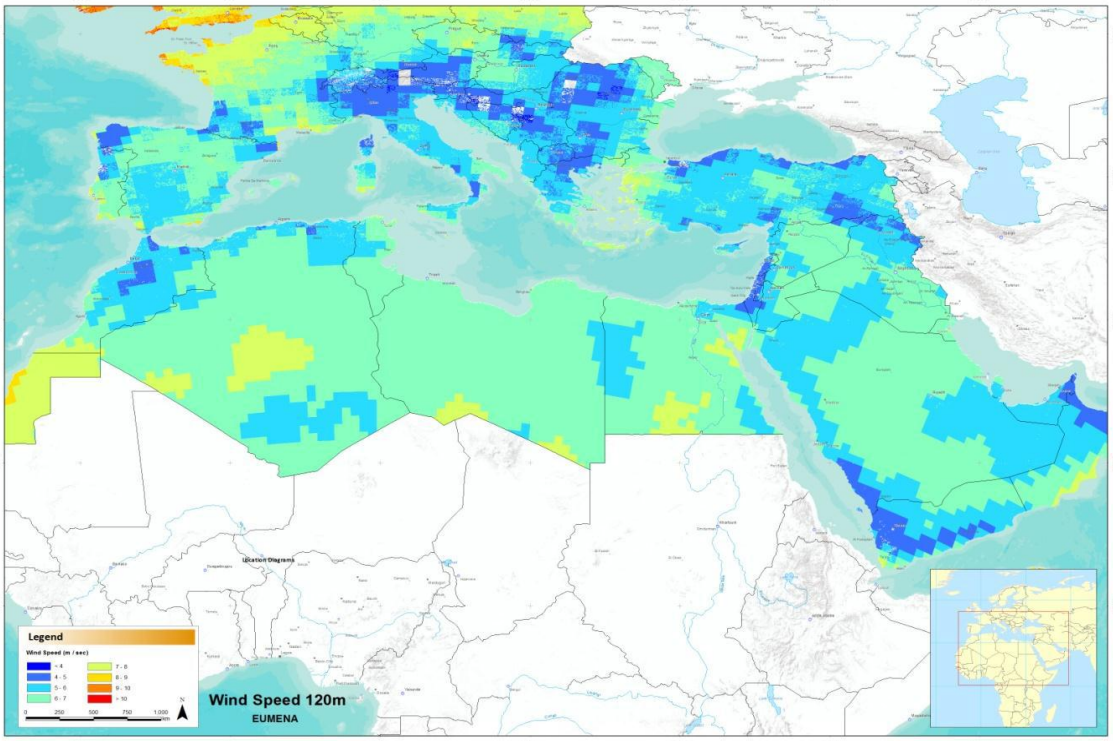


Figure 14: Wind Potential MENA. *Source: Dii*

In the scope of promoting wind energy in Tunisia, and implementing the state's renewable energy policy, a Wind Atlas for Tunisia was established in 2009. It provides data on wind resources in Tunisia and identifies the potential by region. Measurements were made at 20 and 40m. The atlas is presented in GIS format (Geographic Information System) and data overlays are available in 10m, 60m, 80m and 100m. It shows that there are good wind conditions (speed exceeding 7m/s at 60m hight) in the regions of Bizerte and Nabeul, in the central regions (Kasserine) and in the southern regions (Tataouine, Western Cape, Gabes, Kebili). The realization of the atlas required the development of wind measuring masts in 17 different sites, and the use of statistics and data from the National Institute of Meteorology. Funding was supported by the Spanish Agency of International Cooperation for Development, AECID, CENER and the Community of Navarre, in partnership with ANME who led the project.

Considering the ratios in terms of MW installed per unit area, and occupancy of 1% of the country, the gross wind energy potential in Tunisia is estimated to more than 8000 MW.

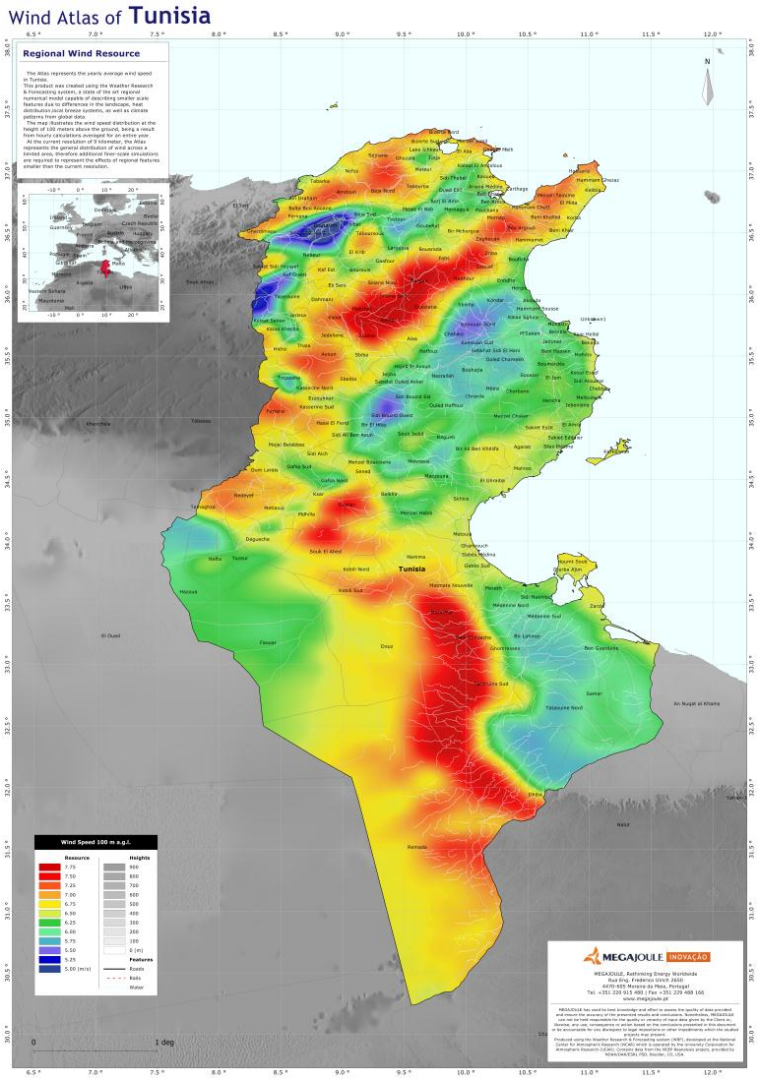


Figure 15: Tunisian Wind Atlas. *Source : ANME*

3. Solar Resources

Tunisia benefits of more than 3000 sunshine hours per year. Currently, there is no accurate assessment of solar potential in Tunisia because of the lack of extensive studies made in this direction. Indeed, there is no solar atlas precise enough to evaluate this resource. However as part of the valorization and the qualification of Tunisian solar sites, several weather stations are being installed, allowing us to obtain more precise estimates of this deposit.

A weather station has been installed as part of the cooperation between STEG ER and the German Aerospace Agency DLR, which currently allows data collection (sunlight, radiation, temperature, pressure ...) in the region of Tataouine. Another weather station was installed by STEG in the scope of a 50MW CSP project. A third was installed as part of the Tunisian-Japanese cooperation.

After compiling the data collected with the available satellite data, it was possible, with the collaboration of Dii, to develop maps of insolation presented in what follows. Next figure shows an overview of direct radiation DNI (Direct Normal Irradiance), measured in the MENA region. The map shows the regions with a DNI greater than 1900 kWh/m2.a

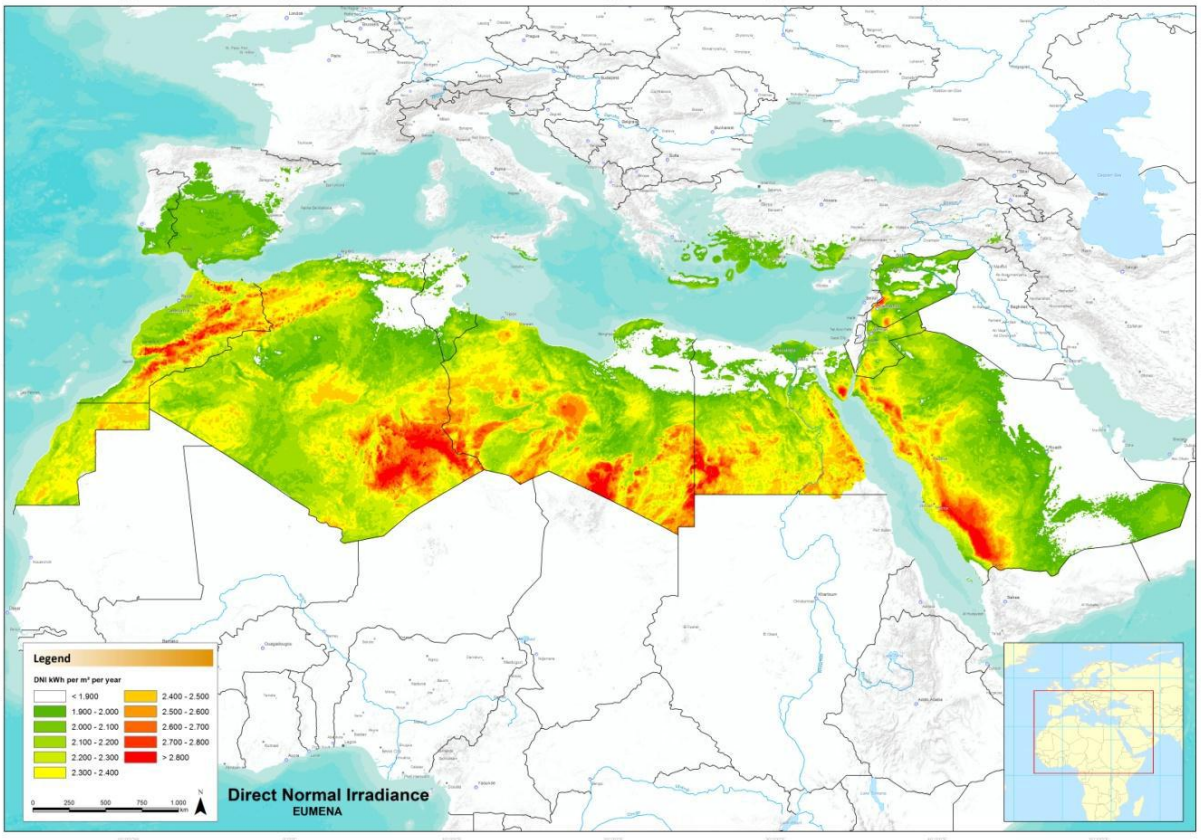


Figure 16: Overview of DNI in MENA region. *Source: Dii*

The following map shows the most suitable areas in Tunisia for the implementation of CSP plants. The first map shows areas of high DNI. In the second map are given areas offering the best potential, excluding protected areas, agricultural land or areas having a slope of more than 2%.

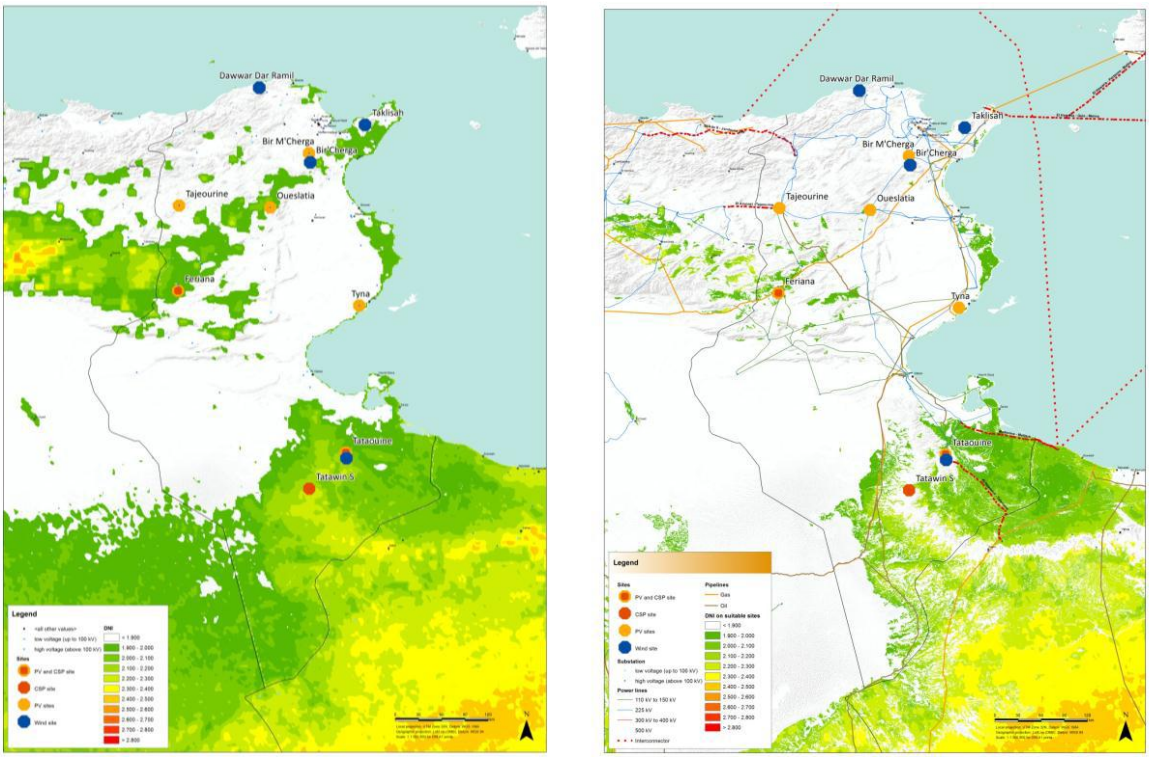


Figure 17: DNI in Tunisia. *Source: Dii*

The highest values are measured in the southern regions and in some west central highlands. In the North, we can find sites with direct irradiation DNI reaching 2100 kWh/m² per year and exceeding 2400 kWh/m² per year, in the South.

For site selection, will be excluded, urban or agricultural areas, protected areas, dunes and land having a slope greater than 2%.

The following figure shows an overview of the Global Horizontal Irradiance (GHI), measured in the MENA region. This map shows the regions with a GHI greater than 1200 kWh/m^2.y.

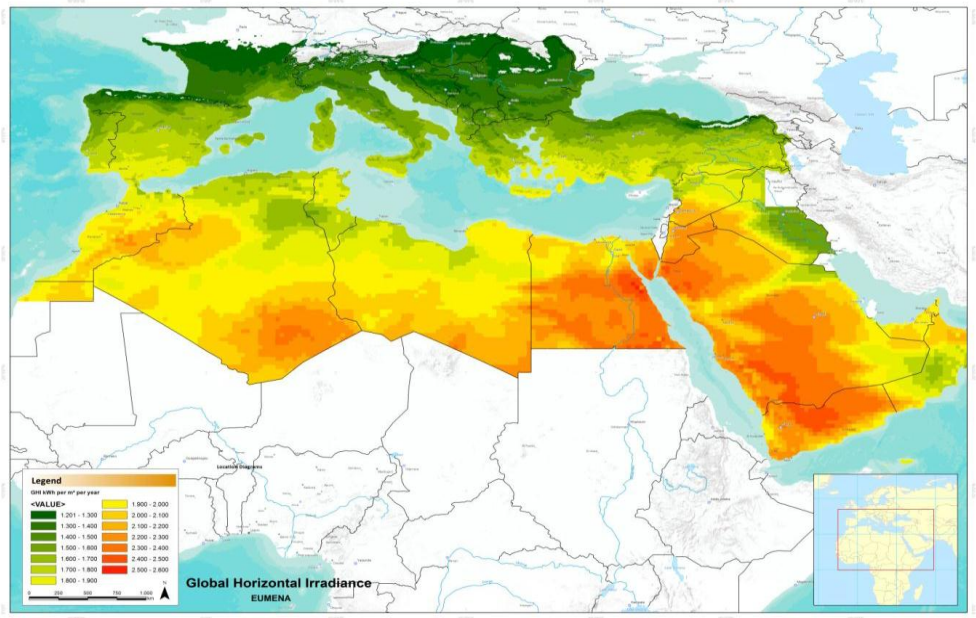


Figure 18: GHI in MENA region. *Source: Dii*

In Tunisia, the GHI ranges from 1700kWh/m2.y - 1800kWh/m2.y in the center of the country and exceeds 2000kWh/m2.y in the South.

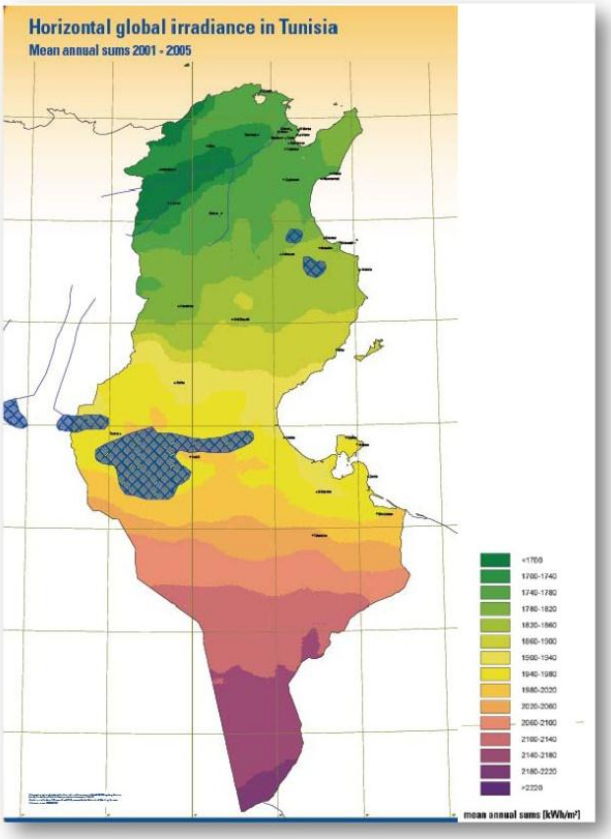


Figure 19: GHI in Tunisia. *Source: ANME*

The following figure shows the regions suitable for the implementation of PV plants. The first map shows areas with high GHI. In the second map are given areas with important potential, excluding protected areas, agricultural land or having a slope of more than 4%.

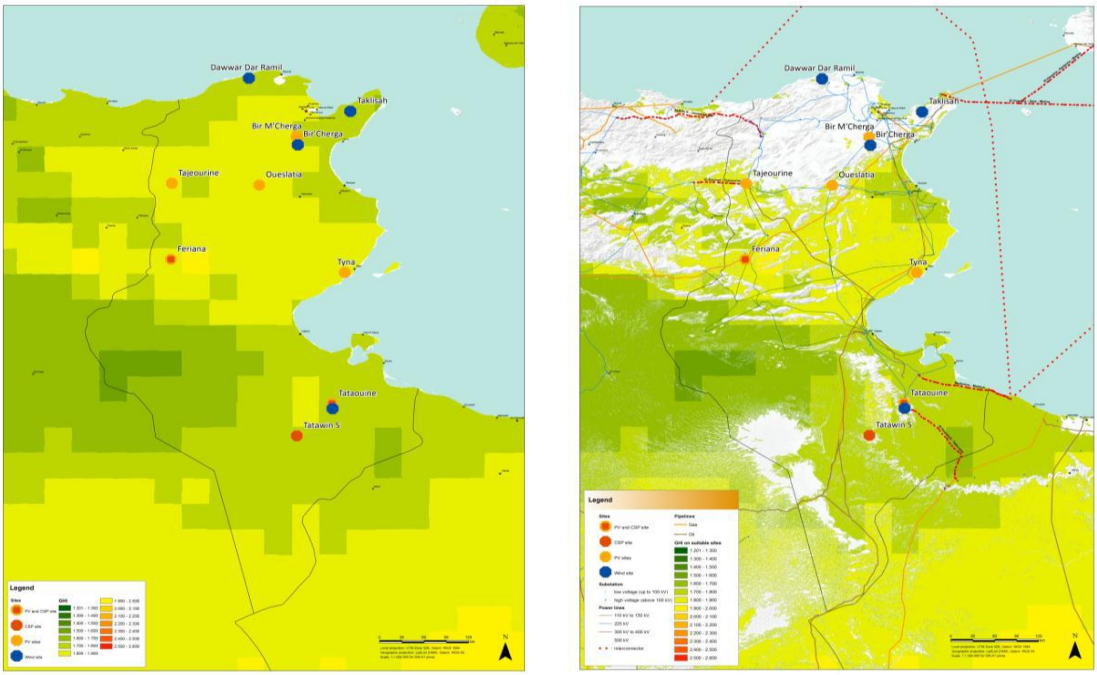


Figure 20: GHI in Tunisia. *Source: Dii*

Areas with highest GHI are located in the south and in some mountainous areas.

For site selection, will be excluded, urban, agricultural, protected areas, dunes and land having a slope of more than 4%.

Unlike CSP, which requires large land and having a slope less than 2%, the suitable sites for installation of PV plants (more modular) are widespread.

4. Criteria for site selection:

To identify the most suitable sites for each technology, the following selection criteria have been adopted:

- **For CSP:**

  DNI> 2000 kWh/m^2.y
  Excluded areas: natural reserves, forests, dunes...
  Slope : <2%
  Access to road
  Proximity to the grid: substation less than 75km
  Availability of water
  Area: 8km^2

- **For PV:**

  GHI> 1800 kWh/m2.y
  Excluded areas: natural reserves, forests, dunes ...
  Slope : < 15%
  Access to road
  Proximity to the grid: substation less than 50km
  Availability of water
  Area: 1km^2

- **For WIND:**

  Wind speed > 6m/s
  Excluded areas: natural reserves, forests, dunes ...
  Access to road
  Proximity to the grid: substation less than 50km

5. Site Inventory

Analysis of these data led to the identification of suitable sites for installing renewable energy power plants (CSP, PV and Wind) with a capacity of up to 1000 MW. These sites are represented in the following map.

Figure 21: Identified Sites

The potential for each site and technology are summarized in the following table.

Technologie	Site	Puissance MW	Puissance MW
CSP	Tataouine Sud	250	400
	Feriana	150	
Eolien	Bir M'Cherga	60	300
	Douar Dar Ramel	60	
	Takilsa	120	
	Tataouine	60	
PV	Bir M'Cherga	50	300
	Tataouine	50	
	Oueslatia	50	
	Tyna	50	
	Tajerouine	50	
	Feriana	50	
	Total	**1 000**	**1 000**

Table 15: Identified Sites

To pinpoint the exact potential of these sites, it would be wise to conduct an additional measuring campaign. The installation of weather stations to measure solar radiation and wind measuring masts for wind power plants is a prerequisite to launching projects.

As mentioned above, Tunisia has neither sun atlas nor an accurate assessment of its solar resources (DNI). We suggest that as it was the case for the development of the Tunisian wind atlas, ANME, in partnership with relevant agencies, launches such an initiative.

Moreover, it is important to note that ANME is now refining the wind atlas. A new version, more accurate and including more data on sites specificities, is being developed.

The use of the National Meteorological Institute (INM) in such work would be beneficial. In fact, the INM is represented by six regional subdivisions (Tunis, Jendouba, Sousse, Sfax, Tozeur and Medenine).

These subdivisions represent the INM in regions and their mission consists on:

- Providing meteorological services necessary for the safety of air and maritime navigation at regional scale.
- Implementing of the National Institute of Meteorology's directives.
- Participating in studies of weather factors that may contribute to regional economic development.
- Managing weather stations' activities linked to the subdivision.

Furthermore, the INM has an observation network classified by type of station:

- Synoptic Network: 26 stations
- Agro-meteorological Network: 31 Stations
- Climatological Network: 58 Stations
- Rainfall Network: 208 stations
- "Radar" Network: 1 Radar
- Seismological Network: 15 Stations
- Network Station to measure the background pollution: Station 1
- Network of Maritime Stations: 7 Stations

The main weather stations are shown in the following map:

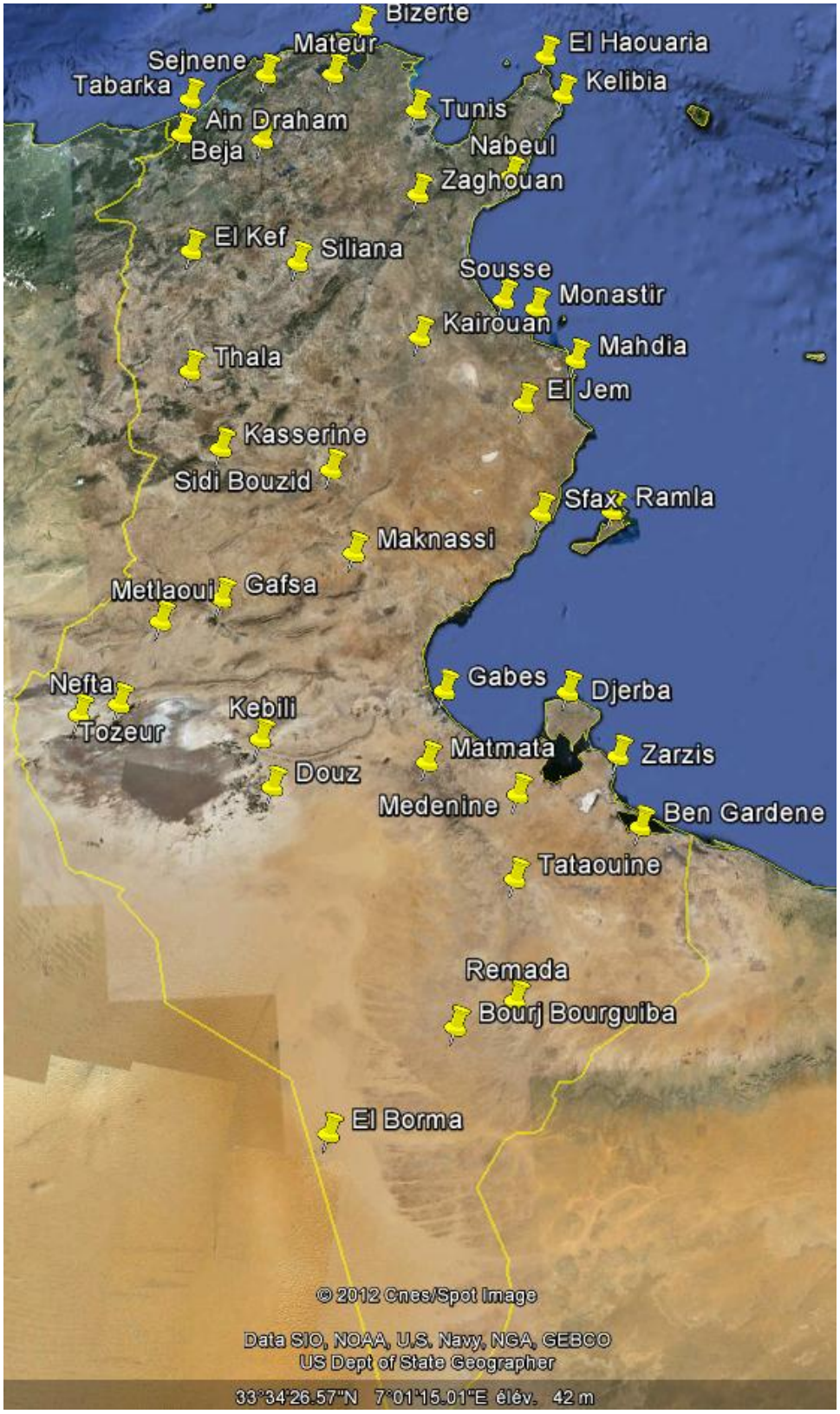


Figure 22: Weather Stations Map

IV. Infrastructure in Tunisia

1. Road Network in tunisia

The road network in Tunisia is governed by the law 86-17 of 7 March 1986 revision of the legislation on the Public Road Domain of the State (DPR). This law is applied for all road parts of DPR of the state, excepting military roads.

This law has defined:

- Consistency of the public Road Domain of the state;
- Rosters (limits and control constructs roadside);
- Temporary occupation of DPR;
- Special provisions for Highways;
- Rights and obligations of residents;
- Police and the conservation of DPR.

According to this law, the roads are classified into three categories:

- National Roads (RN);
- Regional Roads (RR);
- Local Roads (RL).

RN and RR are classified by order; RL are classified by order of the Minister of Equipment and Housing.

By law 86-17 of 7 March 1986, we have the following definitions:

1. The National Roads: all roads are designed to provide links between the borders of the country. Highways are classified as national roads;

2. The Regional Routes: All roads are designed to provide communications between two or more parts of the country.

3. Local Roads: all roads are designed to provide communication of local interest or agricultural.

The Tunisian road network consists of about 19 412.6 km 13,139.8 km of roads paved and 6 272.8 kilometers unpaved as follows:

National Roads: 4078,7 km

Regional Roads: 6521,8 km

Local Roads: 5849,4 km

Highways: 400 km

Under Classification: 2562,7 km

	Paved Roads				
Width of the road	**< 7 m**	**> 7 m**	**TOTAL**	**Unpaved**	**TOTAL**
National Roads (RN)	537.4	3392.6	3930	148.7	4078.7
Regional Roads (RR)	2012.9	3103.5	5116.7	1405.1	6521.8
Local Roads (RL)	1862.6	588.9	2451.5	3397.9	5849.4
Under Classification	806.4	435.2	1241.6	1321.1	2562.7
Highways		400	400		400
TOTAL (km)	5219.3	7920.2	13139.8	6272.8	19412.6

Table 16: Road Network (km)

Figure 23: Tunisia Road Map

Sites Situation

Site	Region	Latitude	Longitude	Technology	Capacity (MW)
Dawar Dar Remal	Bizerte	9°-19'-48''	37°-00'-00''	Wind	60
Takilsa	Nabeul	10°-46'.1-19''	36°-49'.15-59''	Wind	120
Bir Mcharga	Zaghouan	10°-3'.2-99''	36°-27'.3-0''	Wind	60
Bir Mcharga	Zaghouan	10°-3'.2-99''	36°-27'.3-0''	PV	50
Ouelatia	Ouelatia	9°-36'.18-00''	35°-49'.51-60''	PV	50
Tajerouine	Kef	8°-32'.45-59''	35°-51'.10-80''	PV	50
Tyna	Sfax	10°-38'.27-60''	34°-41'.16-80''	PV	50
Fériana	Kasserine	8°-32'.23-99''	34°-55'.22-80''	PV	50
Fériana	Kasserine	8°-32'.23-99''	34°-55'.22-80''	CSP	150
Tataouine	Tataouine	10°-29'.50-99''	32°-58'.3-00''	Wind	60
Tataouine	Tataouine	10°-29'.50-99''	32°-58'.3-00''	PV	50
Tataouine Sud	Tataouine	10°09'.7-29''	32°-36'.14-35''	CSP	250

Tableau 17: Sites Situation

The following figures show the service of the sites roads from the closest harbor for heavy equipment transport.

Figure 24: Road Bizerte - Douar Dar Ramel Site

Figure 25: Road Rades- Bir Mcherga Site

Figure 26: Road Rades-Tajerouine Site

Figure 27:Road Sousse- Oueslatia Site

Figure 28: Road Sfax- Fériana Site

Figure 29: Road Zarziz - Tataouine &Tataouine South Sites

2. Port Infrastructure

Tunisian trades carried by sea account for 98% of the total trade, and about 20% of these exchanges are general cargo and transported by container, trailer or alone. The 23 shipping lines that connect Tunisia to Mediterranean ports allow, among other connections, a daily departure flow to Marseille and Genoa.

- The port of Bizerte-Menzel Bourguiba: located north of the country, is dedicated mainly to oil traffic.

· Dock: 10 berths; draft of 8m to 11m, total length of dock 1.390m
· Superstructure: 14 stores with a total area of 8.680m2, medians: 22.000m2.

- The port of Rades: processes all of roll-on/roll-off and containerized in Tunisia and a share of bulk traffic (cereals, oil).

· Dock: 11 berths; draft of 8.40 m to 10.60 m total length of dock 2.020m.
· Superstructure: 5 stores with a total area of 30.000m2 (1.200m2 with 4 º C isotherm); medians: 18.5 ha.

- The port of La Goulette: dedicated, since the opening of the port of Rades for the international trade, general cargo and car ferries and cruise ships.

- Dock: 7 berths, draft 9.00 m total length of dock 1.090m.
- Superstructure: 11 stores with a total area of 48.200m2; medians: 12.5 ha.

- The port of Sousse is a cargo port.

- Dock: 10 berths, draft 9.00 m to 10.50 m total length of 980m dock.
- Superstructure: 5 stores with a total area of 13.000m2; medians: 14.7 ha.

- The port of Sfax Sidi-Youssef: is a multipurpose port.

- Dock: 13 berths; draft 10.50 m total length of dock 2.590m.
- Superstructure: 9 stores with a total area of 23.500m2; medians: 24 ha.

- The port of Skhira: specialized in Petrochemical traffic mainly for petroleum and chemical products from Skhira chemical plants.

- The port of Gabes: specialized in chemical products traffic from chemical plants of Gabes.

- Dock: 10 berths; draft 10.50 m to 12.50 m total length of dock 1.830m.
- Superstructure: a shed with a total area of 4.000m2; medians: 15 ha.

- The port of Zarzis is currently exporting the crude oil from Ezzaouia field, connected to the port by a seven kilometers pipeline. The activity of this port is related to the startup and projects of the Free Zone area.

- Docks: 4 berths; draft 10.00 m to 12.00 m total length of 950m dock.
- Superstructure: a shed with a total area of 5.000m2; medians: 32 ha.

- The port of Enfidha (project): expected to be completed during the XIIth economic development plan, this project will be implemented in full BOT. Covering an area of 1000 hectares, it will include 3600m of quay for containers, 1400m for bulk, at least 17m dredged, with a total capacity of 5 million TEUs and 4 million tons of bulk.

Concerning freight transport, the main connection is through the port of Rades (largest port) and that of La Goulette (cargo and passenger port).

Currently, Tunisia lacks a network of logistics platforms in operation and it suffers from a serious lack of storage infrastructure. Nevertheless, it was expected in the eleventh economic development plan (2007-2011) to establish priority areas for the creation of logistics zones, to be operated in concession regime, like that of Jebel Oust, which will serve the area of the Tunisian capital, and one that will serve the port of Rades. Furthermore, the logistics plan of the Ministry of Transport includes a number of strategic, tactical and operational measures for the development of logistics in the country, including: the realization of a logistics zone (ZL), which will serve Enfidha deep water port, connecting of logistic zones to the railway, the encouragement of national "logistics operators" to

participate in increasing trade volume, the physical integration of the chain in terms of facilitating flow.

3. The airport infrastructure

The airport sector in Tunisia, under the Ministry of Transport, is considered one of the strategic sectors for the development of the Tunisian economy. The Ministry of Transport is involved, through the Directorate General of Air Transport (DGTA), in planning and programming of airport infrastructure, through the Office of Civil Aviation and Airports (OACA) and airlines. Currently there are 9 international airports in the country:

- Tunis-Carthage Interational Airport
- Enfidha Interational Airport
- Monastir Interational Airport
- Jerba-Zarzis Interational Airport
- Tabarka Interational Airport
- Tozeur-Nefta Interational Airport
- Sfax Interational Airport
- Gafsa-Ksar Interational Airport
- Gabès Interational Airport

4. Railways

In Tunisia, railway is governed by Law No. 98-74 of 19th August 1998 on railways, Law No. 98-89 of 2 November 1998 on the reorganization of the financial position of SNCFT (National Company of Tunisian Railways) and law No. 98-90 of 2 November 1998 on SNCFT. The latter concerns the revision of Law No. 69-31 of May 1969, concerning the approval of the statutes of SNCFT, which includes the adoption of the concession regime of public domain to SNCFT and the operation of railway services on the basis of a specification. At international level, Tunisia is a signatory to the Protocol of Vilnius (2006) Convention on the International Carriage (COTIF).

The rail network consists of 2,165 km of track (1,991 km are in operation and 673 km for freight only). Lane width is a drawback: 471 km of line has a standard track width and 1686 km have a metric track width.

5. Logistics in Tunisia

The most recent macroeconomic indicators, published by the Ministry of Transport, are:

- The logistics sector represents 7% of GDP and 15% of investments in the country.
- Its average annual growth rate expected during the period (2007-2011) is 6.1%.
- The amount of planned investment by this sector for the period (2007-2011), is 6 528 million TND, of which 42% by the private sector.
- It has 120 000 direct jobs (not taking into account indirect job creation).

Tunisia is a pioneer in logistics development among the countries that have the same standard or those belonging to the entire MENA (Middle East and North Africa). The World Bank has developed from the 2007 data, a tool for comparing the performance of different

logistic countries worldwide, the Logistics Performance Index (LPI). In this ranking, Tunisia is in 60th position out of 150 countries.
Currently the costs associated with logistics represent about 20% of GDP (see table below).

Spending on logistics by sector
*in million TND (2007)

	GDP*	Logistics*	% of GDP
Manufacturing	7 333	4 900	67 %
Non-manufacturing	5 415	1 200	22 %
Commercial services (excluding transport)	12 175	1 800	15 %
Agriculture and fisheries	4 809	675	14 %
Transports	4 000	175	4 %
Non-commercial activities	5 980	100	2 %
Taxes	4 530		
Total	**44 242**	**8 850**	**20**

Table 18: Spending on logistics by sector

Source: Development Strategy services and logistics infrastructure in Tunisia, World Bank

Transport companies

	Workforce	National transport companies	international road transportation companies	Total companies	Total
Number	1 070	515	63	578	1 648
Semi-trailers	490	5207	340	5 547	6 037
Tractors	486	4 619	385	5 004	5 490
Trucks	150	715	14	729	879
Trailer	8	115	4	119	127
Total	1 134	10 656	743	11 399	12 533
payload (CU)	15 061	155 553	9 285	164 837	179 898
%CU	8%	86%	5%	92%	100%

Table 19: Transport Companies

Source: Ministry of Transport, direction générale des Transportes terrestres (2008)

Investments in the transport sector (million TD)

Sub-sector	Xth Plan (2000-2006)	XIth Plan (2007-2011)
Rail	692	1 782
Road	1 691	2058
Maritime	1 127	1 004
Airlifted	1 090	1 684
Total transports	4 600	6 528
Total transports (relative to the total Plan)	8,4%	8.1%

Table20: Investments by sub-sector

Source: Ministry of Transport, direction générale des Transportes terrestres

List of maritime professionals to 31/12/2009

Profession	Number
Shipping consignees	308
Cargo Consignees	17
Charter brokers	71
Tanker ships	98
Management companies of merchant ships	12
Business assistance, rescue and towing at sea	3
Representative office of foreign companies ship classification	1
Freight Agents	87
Total	**597**

Table 21: List of maritime professionals

Source: Ministry of Transport, direction générale des Transportes terrestres

6. Water Resources

Tunisia has a Mediterranean climate. It has three main sets of climatic stages:

- At north, a "wet" area (400 to 600 mm / year) which supplies the vast Medjerda hydrographic network;
- In the center, both sides of the "backbone", precipitation ranges from 250 to 400mm;
- In the south, an arid area (less than 250mm/year or less than 150 mm south of Douz);

The country has about 4.6 billion m3 of water: 60% flows to the surface, 40% are underground but 80% of water resources are located in the north while 70% of groundwater is located in south. Each Tunisian has theoretically 450m3/year which is below the "water stress", commonly attached to 500m3/year/hab.

The country has also groundwater in the north and huge resources consisting of aquifer in the south. Salinity is more important (1.5g/l) north.

In Tunisia, there are 29 conventional dams, 221 other dams and 741 mountain lakes, 5200 deep wells and 130 000 surface wells (2004 data).
Distribution of drinking water is ensured by the National Company of Water Exploitation and Distribution (SONEDE), it was created by Law No. 68-22 of July 2, 1968. It is under the Ministry of Agriculture. Its status is defined by law and it is a public industrial and commercial institution.

SONEDE is committed to:

- Provide all the national territory with drinking water;
- Operation, maintenance and renewal of water collection facilities;
- Transport, processing and distribution of water.

In this scope, SONEDE has established central, regional and local structures. It has currently 7500 employee and manages 1.4 million subscribers supplied with water through 30,000 km of pipelines by passing a production of 317 million m3 per year. For isolated sites, SONEDE cannot connect plants to its water distribution network; in this case it must have permits from the Ministry of Agriculture to make the necessary drillings to satisfy plant's needs in industrial water.

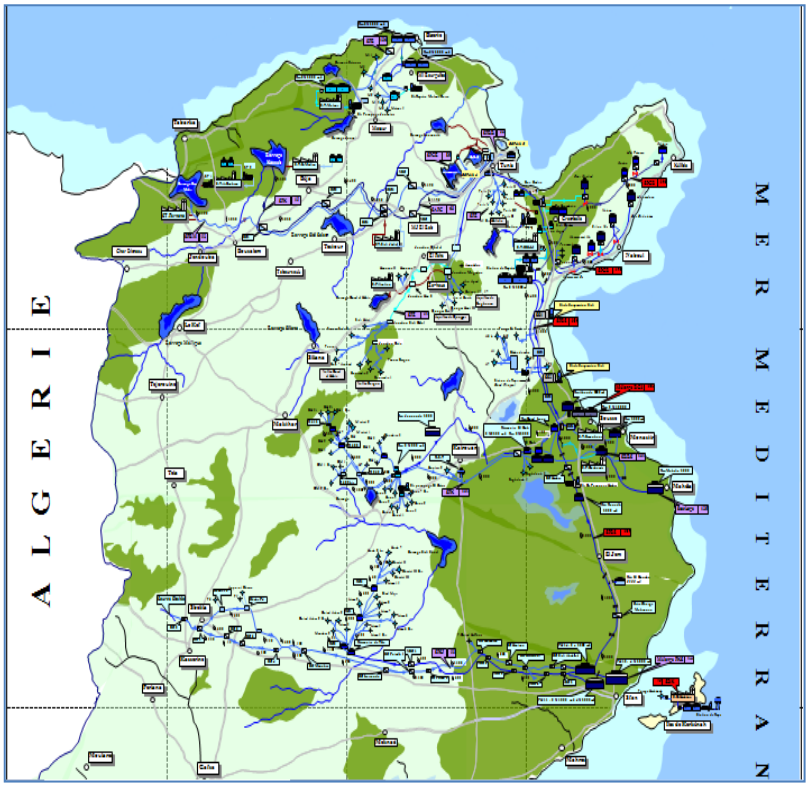


Figure 30: Water production systems North and Central

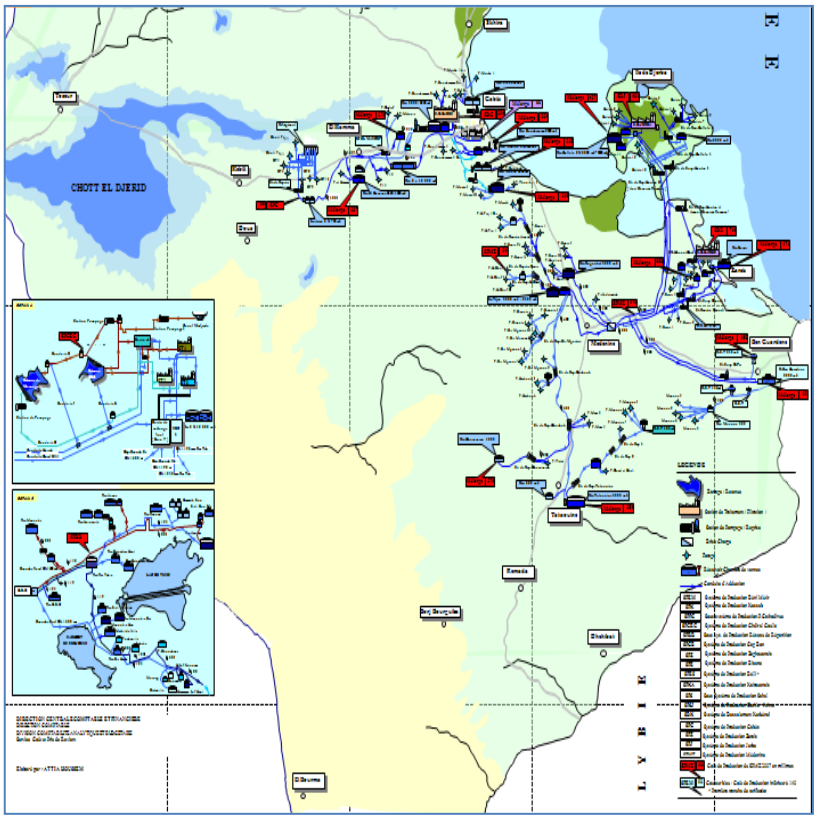


Figure 31: Water production systems South

The following figures show the water table in the areas selected for the implementation of the CSP power plants.

- **Fériana site (Governorate of Kasserine)**

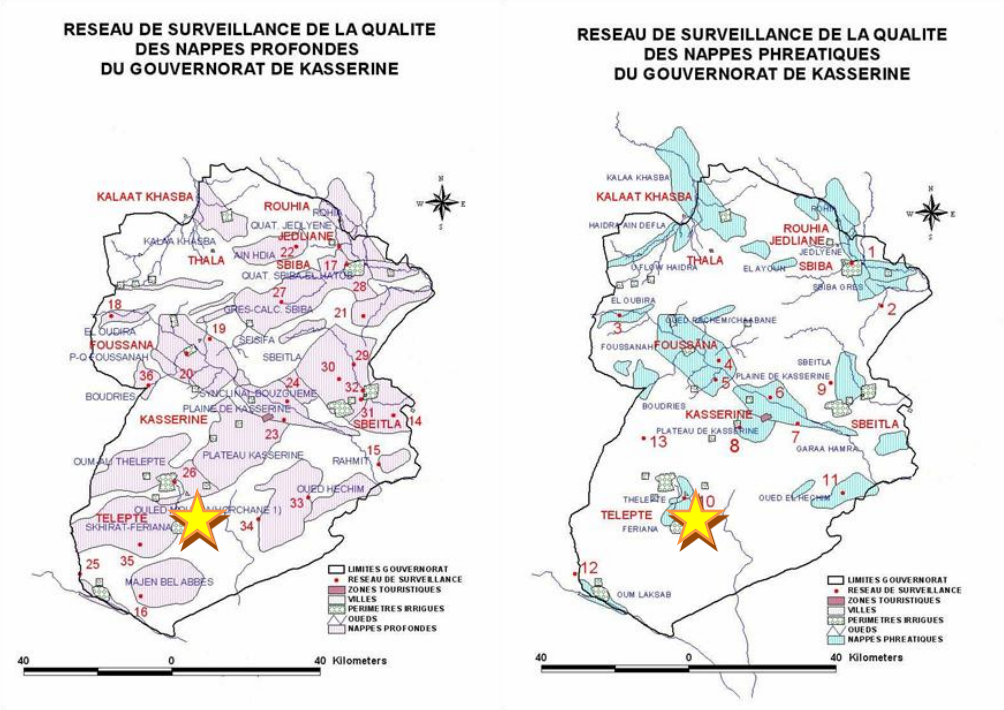


Figure 332: Deep groundwater Feriana

- **Tataouine South Site (Governorate of Tataouine)**

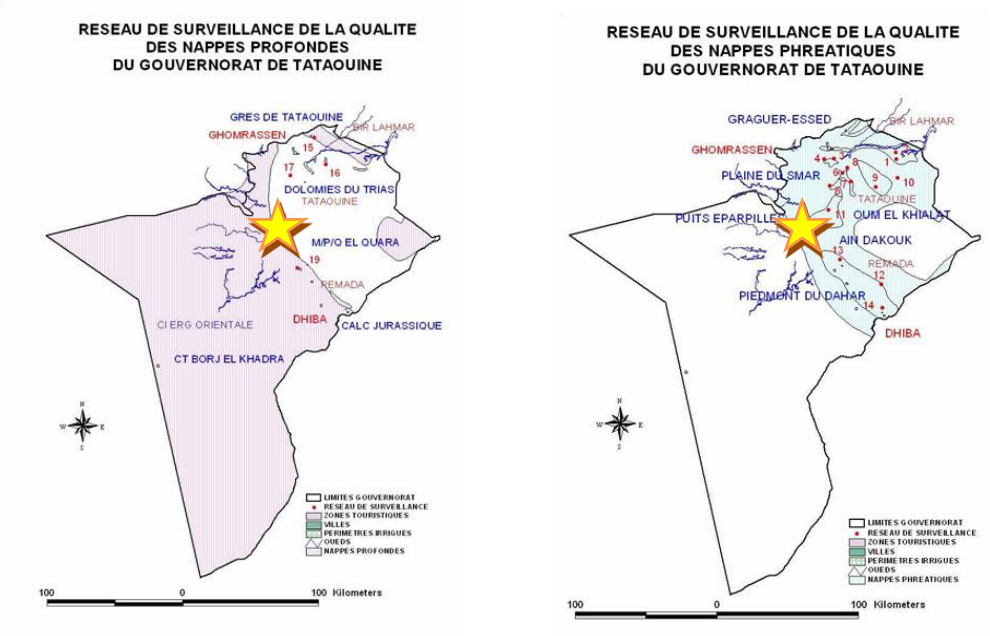


Figure 33: Deep groundwater Tataouine

7. Gas infrastructure

The gas infrastructure has grown considerably in recent years. Indeed, the length of the gas transmission and distribution network has reached 2140 km in 2010.

The most important achievement in the transmission network took place in 1994 with the establishment of the pipeline Msaken-Gabes which first allowed the transport of Algerian gas to Gabes and in 1996, and then the transport of Miskar gas northward and southward. In 1999, Nabeul-Tunis pipieline and Rades-Mornag pipeline were constructed to rescue and strengthen the power of the platform of Tunis.

The year 2003 was marked by the planned construction of compression units in Gabes allowing the optimization of gas from the south by the discharge of the excess gas to the North.
In 2007, a new LPG plant in Gabes started operating and allowed better utilization of gas from the south and an improvement in the production of LPG.

The duplication of TRANSTUNISIEN pipeline in 1994 has enhanced the availability of natural gas by increasing transited amounts. In 2008, this availability was strengthened by the installation of new compression units in the pipeline

However, estimates of gas availability and development of the demand show a deficit of gas of 7 ktoe appearing from 2021. This deficit could be filled by additional quantities of gas from Algeria or the use of means of power generation with a fuel substitute.

The following map shows the location of the existing infrastructure:

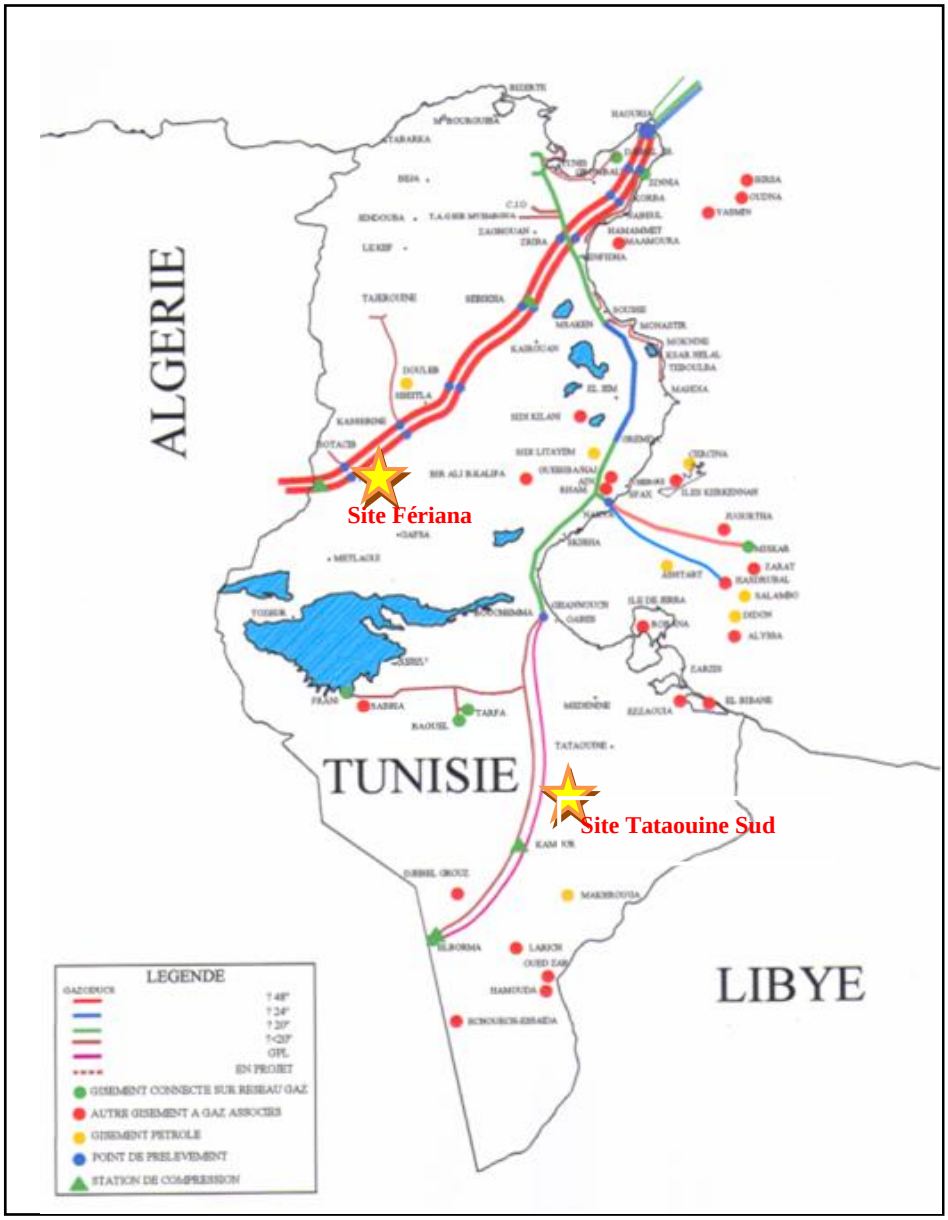


Figure 34: Gas Infrastructure in Tunisia

Note: Feriana and Tataouine South sites can be connected to the HP Gas, which makes them well suited for the installation of hybrid CSP plants.

V. Assessment of environmental and socio-economic impacts

1. Assumptions of the impact study

The considered technologies:
In order to establish a realistic assessment of the environmental impact of this project, it is first necessary to identify the technologies that will be implemented in this project knowing that they should be those most adapted once to the Tunisian context.
We relied heavily on the technological choices that were discussed and accepted as part of the study for the Tunisian energy mix by 2030, conducted in 2011 by the group Wuppertal Institute / ALCOR, on behalf of the General Direction of Energy, with funding from the GIZ.

- **Wind Farms :**

Wind turbine onshore technology is relatively mature in Tunisia. Wind turbines with integrated three-bladed rotor in a horizontal platform are used currently on the market. The rated power of considered machines is 2 MW. It is currently the most used size today.

The lifetime of the parks was set at 20 years, which is relatively conservative. We could expect a lifetime of 25 years, if the machines are well maintained.

Regarding the quality of wind sites selected for the project; we considered an average load factor of 30%, which corresponds to 2630 full load hours, the equivalent of 2.6 MWh/MW per year.

- **Photovoltaic Power plants:**

Photovoltaic power plants, which average life span was set at 25 years, consist mainly of:

- The field of solar modules installed on a fixed support. The technology considered for the cells is the polycrystalline modules, the most widespread technology in the world;
- One or several inverters converting the direct current of the solar generator in alternating current;
- A transformer for connection to medium voltage grid;

As sunlight is converted directly and instantly into electricity, the power of a photovoltaic plant is intermittent and depends heavily on weather conditions, especially on the sunshine of the chosen sites.

In what follows, we will consider global horizontal radiation of 1850 kWh/m², which corresponds to an average production of 1650 kWh / kWp per year.

Concentrated solar power (CSP) :

It is the technology of parabolic trough that will be considered for concentrated solar power plants, since it is the most common technique up to now.

Regarding the location of the sites where these plants will be installed, we consider that the cooling technology of the power plants will be dry cooling.
The annual production of such a power plant for rated output of 100 MW with a storage capacity of 6 hours amounts about 260 GWh[4] for an average site in Tunisia, 2600 hours at full load. The lifetime of these plants is estimated to around 30 years.

The parameters of the different power plants are the following:

	Wind farms	PV Power plant	CSP power plant
Investment (DT/kW)	2000	3250	7500
Lifetime (years)	20	25	30
Load factor (%)	30%	18%	30%
Operations hours (hr/year)	2630	1650	2600
Source : Energy Mix Study-GIZ (2011)			

Table 22: Parameters of Plants by Technology

2. Parameters of the impact study

- **Reduction of greenhouse gas emissions**

This is to estimate the amount of greenhouse gas emissions avoided through the implementation of such a project in substitution to conventional power plants running on natural gas. The emission values will be calculated during facilities lifetime and deducted from the emission factor of the national electricity grid at a ratio of 0.55 tCO2 per MWh[5].

- **Primary energy savings and impact on energy bills**

This is to estimate savings of primary energy, expressed in ktoe, generated through this project in substitution of conventional power stations running primarily on natural gas. We therefore considered an average specific consumption of the conventional generation park of 240 toe / GWh.

[4] *Strategic Study of the Energy Mix for Electricity Generation in Tunisia (2011)*
[5] *Solar Water Heating Program in Tunisia, PoA DD (UNFCCC)*

- **Land use**

The net land use is a factor that depends directly on the space required to install 1 MW of a given technology and the installed power of this technology. The ratios used for different technologies, expressed in ha / MW, are summarized in the following table:

	ha/MW
PV plant	2,5
Wind farm	0.25
CSPplant[6]	4

Table 23: Ratios by Technology

- **Water Consumption**

Water consumption depends directly on the specific consumption of water to provide 1 kWh of electricity for a given technology and the amount of electricity produced by this technology.

- **Influence of Noise (Noise pollution)**

This parameter concerns only wind power plants that emit noise when operating and therefore represents noise pollution for neighboring residences. Nevertheless, wind turbines have become quieter and noise at the household level, can be avoided.
In Tunisia, the level of day noise emitted by an industrial site should not exceed 50 decibels, measured in front of the facade of the nearest house in the area of activity, corresponding to sites with wind speed around 40km/h[7]. Noise reduction can be achieved by keeping a sufficient distance from residential areas (300 meters in Denmark or Sweden). Topographic features, particularly anemometer, site or the presence of vegetation screens can also reduce the level of noise emitted by wind turbines.
The topographic characteristics of the site, specially anemometric characteristics and the presence of plant screens can also reduce the level of noise emitted by wind turbines.

- **Local integration**

The local integration rate is defined as the contribution of the Tunisian industry in the engineering, procurement and construction of new power plants, whose value is estimated as % of total investment. According to various studies in the field, for the case of Tunisia, the following assumptions can be used:

- For wind, only the turbines and blades are imported and the remaining work can be done locally. The local integration rate for a wind farm is estimated to about 43%.[7]

[6] *Middle East and North Africa Region Assessment of the Local Manufacturing Potential for Concentrated Solar Power (CSP) Projects (January 2011)*
[7] *Source: Wind turbines and noise impact (ADEME)*

- For photovoltaics, the local contribution in the realization of PV plants is important, given that the skills needed already exist in Tunisia. For these plants, only the modules and inverters are imported. A local industry is being set up for module production. Considering these facts, the percentage of local integration for PV plants could be around 70%.
- For the CSP, this technology is not yet well positioned in Tunisia and this is why we consider that a large part of the installation will be imported, at least for the first few plants. The local integration rate is estimated in this case at about 20%.

➢ **Job creation**

This is to estimate the number of jobs created through this project on the basis of the employability ratios that were identified as part of the employment study conducted by the group GWS / ALCOR in 2011. Employability Ratios by sector are presented in the following table:

This study used an input-output estimation model, which considers the contribution of the 19 economic sectors (nomenclature according to INS) in the added value created by a unit of investment in RE. The simulations give the following results:

For PV plants, one MW installed would create an estimated 30.5 man-years of employment as follows:

	Man-year/MW
Services	*1,7*
Installation	*15,7*
Production	*1,2*
O&M	*11,9*
Total	***30,5***

Table 24: Jobs created distribution PV

Source : Etude Emploi – GWS/ALCOR pour le compte de GIZ/ANME (2012)

Thus, a PV plant would create about 19 men-year jobs per MW in the construction phase and 0.6 men-years per MW permanent employment in the operational phase.

For CSP plant, the model assesses the employment would create approximately 47 men-years per MW during lifetime, divided as follows:

	Man-Year/MW
Services	*8,6*
Installation	*8,1*
Production	*1,3*
O&M	*28,9*
Total	***46,9***

Table 25: Job Created Distribution CSP

Source : Etude Emploi – GWS/ALCOR pour le compte de GIZ/ANME (2012).

Thus the division between temporary and permanent jobs is as follows:

Temporary jobs	*18*	*Man-years/MW*
Permanent jobs	*1,4*	*Job/MW*

Finally for Wind, simulations give the following results:

		Man-years/MW
Services	100	3,0
Installation	188	5,7
Production	39	1,2
O&M	1094	33,2
Total	**1 420,9**	**43,1**

Table 26: Job created distribution Wind

Source : Etude Emploi – GWS/ALCOR pour le compte de GIZ/ANME (2012).

This would create about 10 men-years temporary jobs per MW, and 1.7 permanent jobs per MW for the operation.

The following table summarizes the employability ratio for the three technologies in the Tunisian context.

Employability ratios	Supply & Installation (man-year / MW)	Maintenance (Jobs/MW)
PV plant	49	7
Win farm	5	0.4
CSP plant[8]	5	1

Table 27: Employability by Technology

Because of the low maturity of CSP power plants in Tunisia, we estimate that job creation relative to the supply and installation component only matches civil works, which can be done locally.

3. Environmental Impact Assessment

Reducing emissions of greenhouse gases

This project will reduce greenhouse gas emissions by about 32 645 kteCO2, accumulated over the lifetime of the equipment, an average equivalent of 1100 kteCO2/year. The distribution of emissions avoided by technology is presented in the following figure:

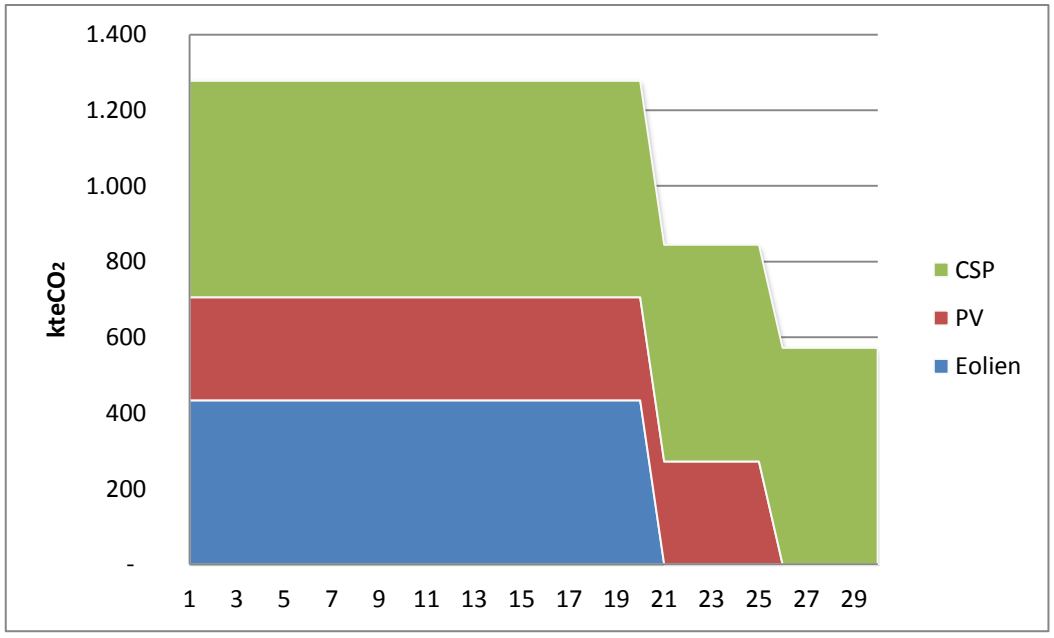


Figure 35: Emissions avoided by Technology

[8] *Middle East and North Africa Region Assessment of the Local Manufacturing Potential for Concentrated Solar Power (CSP) Projects (Janvier 2011)*

Ground occupation

By applying ground occupation ratios by type of technology established previously, the area required for this project is estimated at about **2425 hectares** distributed as follows:

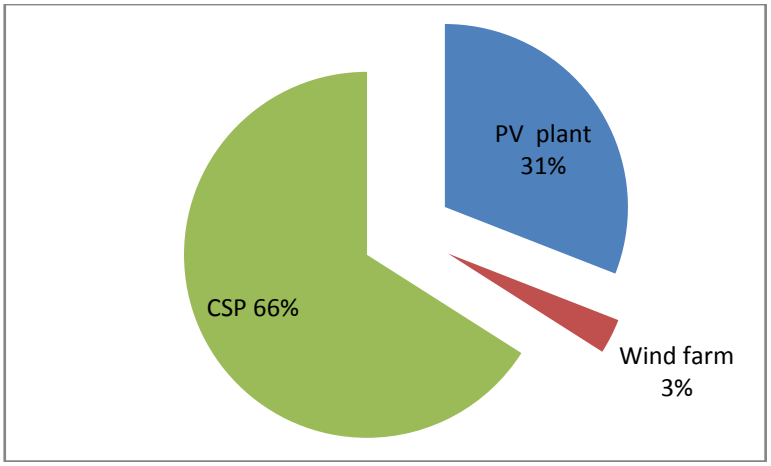


Figure 36: Area by Technology

Depending on the sites, the ground occupation is divided by technology as follows:

Occupied areas

Site	Capacity MW	CSP	Wind	PV	Total
Tataouine South	250	1000			1000
Feriana	150	600			600
Bir M'Cherga	60		15		15
Douar Dar Ramel	60		15		15
Takilsa	120		30		30
Tataouine	60		15		15
Bir M'Cherga	50			125	125
Tataouine	50			125	125
Oueslatia	50			125	125
Tyna	50			125	125
Tajerouine	50			125	125
Feriana	50			125	125
TOTAL	**1000**	**1600**	**75**	**750**	**2425**

Table 28: Area occupied (ha)

The net space occupation is to be put in perspective. The earth quality as well as the reversibility of the alteration of grounds would have also to be considered in order to estimate with more precision the consumption of space.

Water consumption

Water consumption can be considered negligible for wind farms. For PV plants, it will be mainly for mirrors' cleaning. It can be estimated at about 0.1 m^3/MWh[9]. For the CSP, if we consider dry cooling, water consumption can be reduced by more than 90% in comparison to conventional cooling systems. Therefore, it suffices to consider the extra water needed for steam system and water used for the cleaning of parabolic trough mirrors, from 0.16 to 0.30m^3/MWh[10].

Other environmental impacts

In the case of wind farms, the impact on birds and bats is among the most significant environmental effects. The extent and the nature of impacts are related to local characteristics of the chosen site and its location. Thus, the assessment of these impacts requires field surveys, conducted by ornithologists and bat biologists whose main tasks would be:

- Carry out an inventory of species present on site and analyze the level of challenge based on their conservation status;
- Characterize site's use by the birds and establish sensitivity relations of the site's birds stand with the project.

However, considering the locations of certain wind farms (ex: Feriana and Tataouine), the impact issues are probably limited because the considered zones are not situated along important bird migration path.

4. Assessment of socio-economic impacts

Energy saving and reduction of primary energy bill

Based on the productivity ratios mentioned above, the entire project will produce about 2328 GWh per year, distributed among the sites as follows:

[9] *Source : NREL A Review of Operational Water consumption and Withdrawal Factors for Electricity Generating Technologies 2011*

[10] *Source : NREL A Review of Operational Water consumption and Withdrawal Factors for Electricity Generating Technologies 2011*

Electricity generation (GWh/an)

Site	Capacity MW	CSP	Eolien	PV	Total
Tataouine Sud	250	650			650
Feriana	150	390			390
Bir M'Cherga	60		158		158
Douar Dar Ramel	60		158		158
Takilsa	120		316		316
Tataouine	60		158		158
Bir M'Cherga	50			83	83
Tataouine	50			83	83
Oueslatia	50			83	83
Tyna	50			83	83
Tajerouine	50			83	83
Feriana	50			83	83
TOTAL	**1000**	**1040**	**790**	**498**	**2328**

Table 29: Electricity Generation

On this basis, the project would save annual primary energy of about **475 ktoe / year**. These savings are about **14 million toe** cumulated over the lifetime of the facilities.

The evolution of energy savings by sector is presented in the following figure:

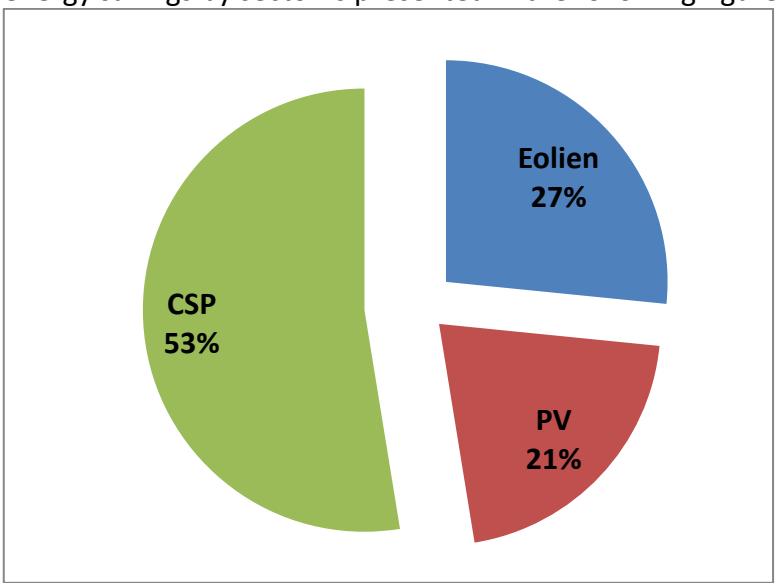


Figure 37: Primary Energy Savings by technology

Values obtained for: CSP only with 6 hours of storage, 40% of installed capacity;
Wind: 30% of installed capacity; PV: 30% of installed capacity

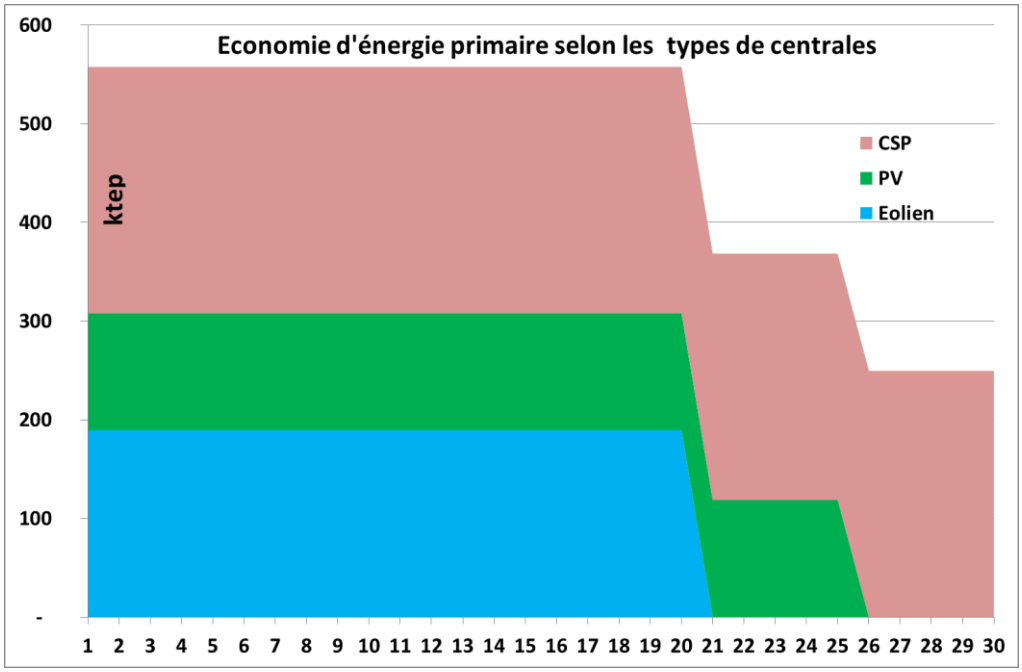


Figure 38: Primary Energy Savings

As an indication, based on the cost of the toe of natural gas on the market, these savings would decrease the country's fuel bill of around **160 million euros** a year (based on an international price of a toe natural gas in 2011, about 340 € / toe).

The following curve represents the evolution of gas prices over the past 10 years and the expected development. The gas market price in Europe will increase by 30 to 40% by 2015 to reach a price indexed to oil, before falling from 2015.

This upward trend in gas prices can only be an additional argument justifying the major advantage of using renewable energies.

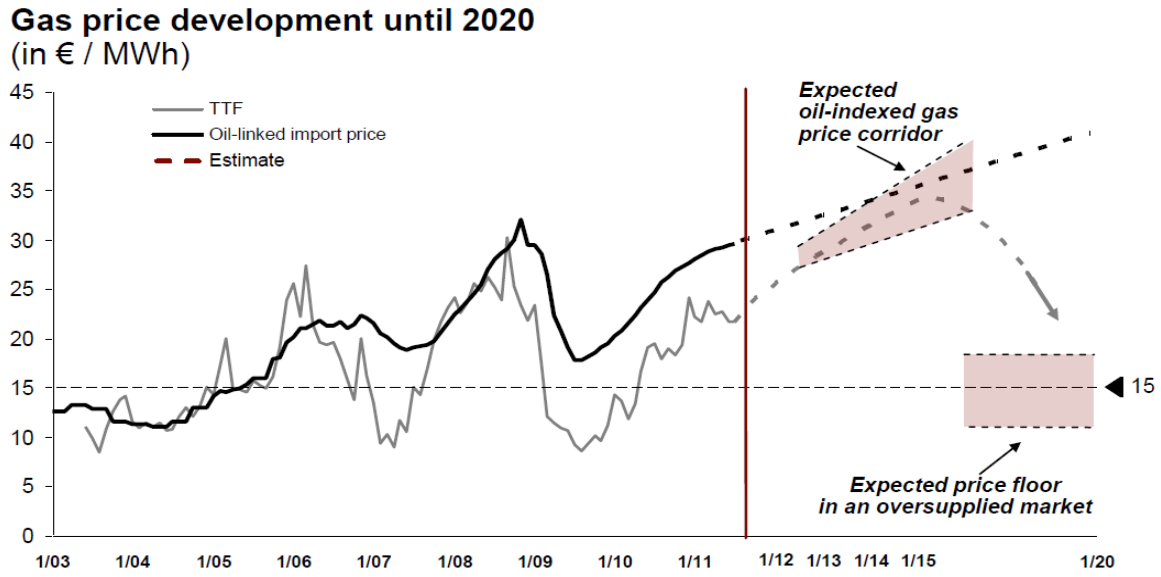


Figure 39: Gas Prices Evolution in Europe *Source: AT Kearney*

TTF : Title Transfer Facility

Impact on employment

In terms of employability, this project will create about 2 028 equivalent jobs as follows:

- 20% about 408 equivalent jobs for photovoltaic plants
- 33% about 660 equivalent jobs for wind farms
- 47% about 960 equivalent jobs for CSP plants.

The distribution of the number of jobs created by plant type and position is presented in the following figure:

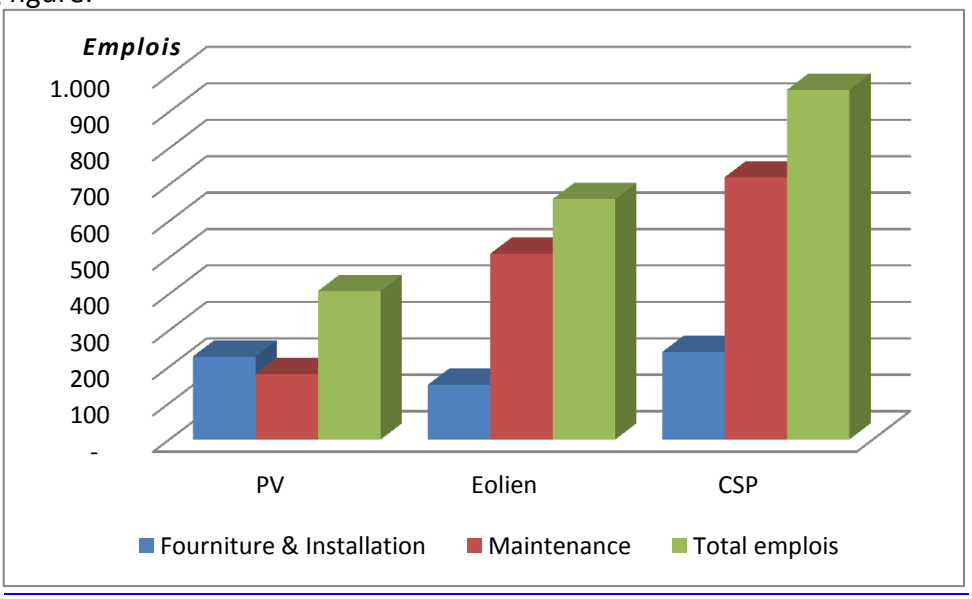


Figure 40: Jobs Created by industry

Rate of local integration

The rate of local integration (RLI) is calculated by weighting the specific integration rates, defined for each sector (RLI_i), compared with the corresponding amount of investment (I_i). This rate is given by the following formula:

$$RLI = \frac{\sum_i RLI \cdot I_i}{\sum_i I_i}$$

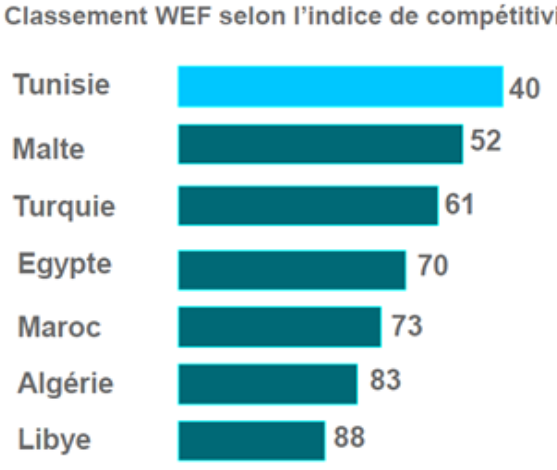
I_i : investment executed in a technology

In application of this formula, the rate of local integration for the whole project is estimated to approximately **34 %**.

Local Companies and expertise

Tunisia has a diversified and well developed industrial base to support the large-scale development of renewable energies for grid connected electricity generation. In particular, Tunisia has approximately 5,700 frims, including 575 industrial companies in the engineering and metal industry (including 160 totally exporting) and 350 in the electrical industry (including 220 totally exporting). These companies are able to integrate a large part of the mechanical and electrical equipment necessary for the construction of wind farms and PV or CSP. Tunisia has also more than 20 engineering firms and experts in terms of controlling energy and carbon market.

The entry into force of the free trade agreement with the European Union in January 2008, opened the door to many opportunities for development of the Tunisian industry but also to issues of strong competitiveness. These opportunities are particularly true as Tunisia is among the efficient and competitive economies on the southern shores of the Mediterranean, receiving good rankings according to the Competitiveness Index prepared by the World Economic Forum in Davos: 40th country in the world rankings, ahead of nearly twenty countries of the Euro zone.



Pays	Rang
Suisse	1
Allemagne	7
France	16
Belgique	18
Chine	29
Espagne	33
Tunisie	**40**
Portugal	43
Pologne	45
Afrique du sud	46
Italie	48
Malte	52
Hongrie	58
Turquie	61
Roumanie	64
Égypte	70
Grèce	71
Maroc	73
Algérie	83
Libye	88

Source : World Economic Forum, 2009-2010

Figure 41: Ranking according to the WEF competitiveness index Source: WEF

Vocational training and university

Skills development in renewable energy has always been an essential component of national energy management programs. This component has been integrated into various academic or professional courses and is also the subject of continuing education programs and capacity building.

The Academic training

There are six universities between public and private engineering schools and Higher Institutes of Technological Studies (ISET) that train engineers, master graduates and technicians who will help prepare and implement projects in the field of renewable energy. Today, about 300 graduates operating in the sector and more than 700 students are currently training for the specialized public and private institutions.

Vocational training

The upgrade training program (MANFORM) has referred since its launching the creation of a new generation of sectorial training centres, which should produce a targeted way of skilled labor and immediately operational in different activity branches in various sectors, from which energy. The vocational training system has about 150 centres belonging to the public and private sectors with a capacity of around 60,000 training places over 90% in public facilities and about 40% in specialized sectorial centres. Moreover, there is a lifelong training plan funded, among others, by a discount on Vocational Training Tax (TFP) and support for Technology Investments (ITP). ANME, as part of its mission, also develops training activities for various stakeholders in the field of energy management in general and renewable energy in particular. All these activities helped build knowledge, improve sustainable business competitiveness and promote the emergence of professionals in the field of renewable energy.

Development of local industry

A scenario favouring development of RE could justify a large-scale implementation of a local industry or at least at a regional level (MENA). In fact, the participation of local companies in construction and engineering related to the commissioning of new power plants in MENA could offer promising prospects.

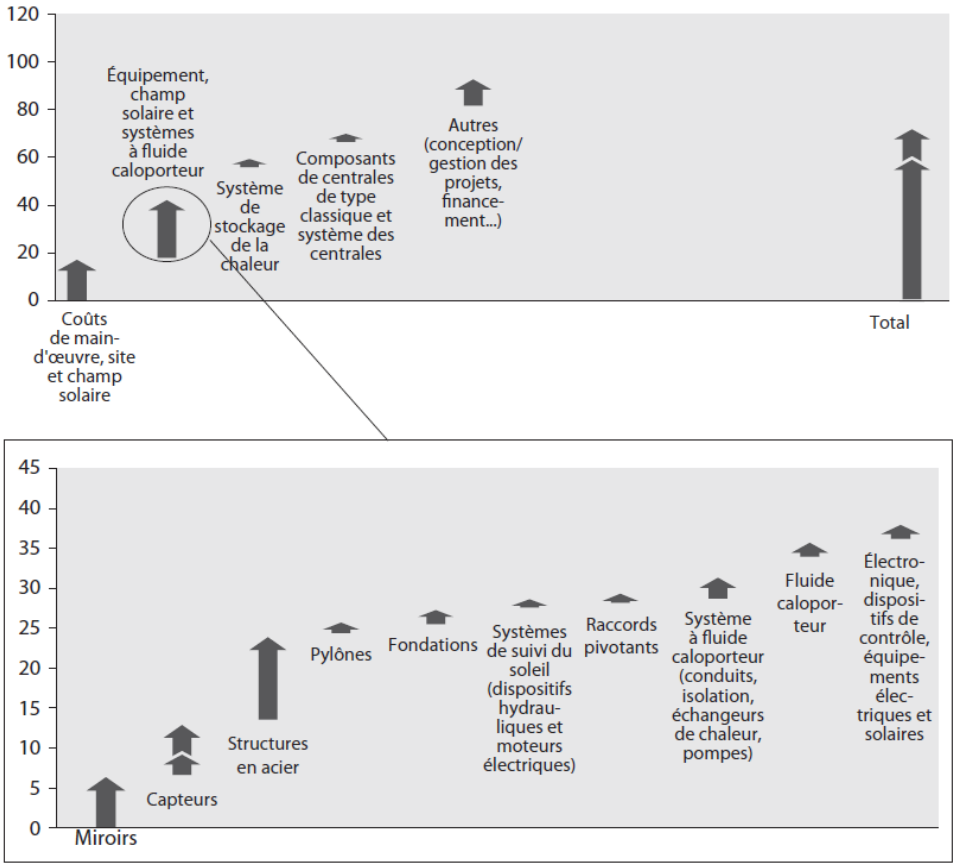


Figure 42: Estimate of the proportion of components potentially manufactured in MENA

Source: ESMAP 2010 CSP Job Study

Taking the example of CSP, a study appointed by the World Bank (ESMAP - CSP Job Study) suggests that the percentage of local integration, during the construction phase of a 50MW CSP plant, could reach 60%.

APPENDIX

Registered offices
Bonn and Eschborn, Germany
T +49 228 44 60-0 (Bonn)
T +49 61 96 79-0 (Eschborn)

Dag-Hammarskjöld-Weg 1-5
65760 Eschborn, Germany
T +49 61 96 79-0
F +49 61 96 79-11 15

E info@giz.de
I www.giz.de